



Rolled Lead Sheet The Complete Manual

Foreword

The Lead Sheet Training Academy (LSTA), previously the Lead Sheet Association, is the UK's leading provider of training in the use of Rolled Lead Sheet to BS EN 12588. Focused solely on providing training, the LSTA builds on the many years' experience of training undertaken by the LSA to support the industry in developing a highly skilled workforce for the future with nationally recognised qualifications, and with a range of courses delivered by the country's best tutors from its purpose-built training centre.

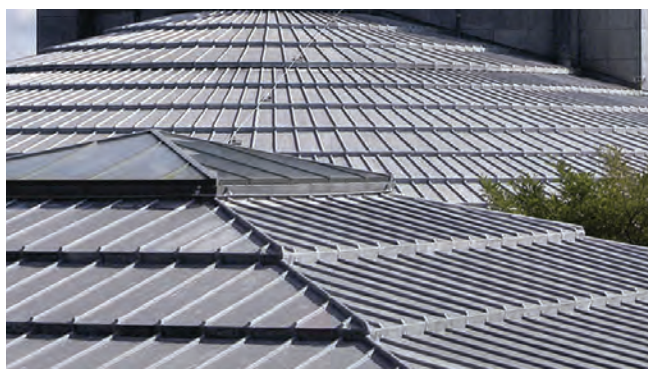
Alongside its training commitments, the LSTA will continue to publish the Rolled Lead Sheet Manual to provide those it trains with key guidance for their learning and a consistent set of guidelines for the wider industry. This Manual has gone through many iterations over the years. Any leadworker following its guidance can be confident that the lead sheet they install will be very long lasting and provide excellent value for money whether it is used for refurbishment or on a new building.

Inevitably small changes need to be made between editions as regulations change and standards are updated. Any such changes are regularly updated on the e-version of this manual which all purchasers of the printed copy of the Manual are automatically entitled to access.

Any necessary changes are now overseen by an editorial board comprising experts from the LSTA and its sponsors. Suggestions for changes will always be welcome from anyone involved in the use of lead sheet and should be sent to the LSTA at the address below.

Health and safety

Lead contractors should be professional tradesmen experienced in the correct procedures in handling lead. If in any doubt, refer to the manufacturer's data safety sheet or the LSTA publication Working with Lead in Construction.



Technical enquiries

As the LSTA is focused solely on delivering high quality training for the industry it will not be able to handle individual technical enquiries. Users wanting more help or advice on the specification, installation or maintenance of rolled lead sheet should contact the technical department of one of the LSTA's sponsors or visit the LSTA website where there is a limited amount of further information. The contact details are:

BLM British Lead: Telephone 03303 333535 or email technical@britishlead.co.uk

Calder Lead: Telephone 01244 393710 or email technical@calderlead.co.uk

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Training

at the Lead Sheet Training Academy

The Lead Sheet Training Academy is at the forefront of training for those using lead or hard metals in the construction industry.

A nationally recognised training centre

To deliver this training the LSTA operates from a state of the art, purpose-built training facility at East Peckham in Kent which is open six-days a week for most of the year. The training centre includes full scale training rigs and resources in a well-equipped environment in which to learn as it recreates real-life situations. Where suitable premises are available, we can also deliver basic courses in lead and hard metals at locations around the UK.

The centre is a CITB Approved Training Organisation. Its tutors are experienced trainers, hold qualifications in leadwork, hard metals and teaching and have experience of working on-site. They are all CITB-approved assessors. CITB grants are available for CITB-registered construction businesses to help with course fees. LSTA can offer pay-as-you-learn charges for courses longer than 5-days.

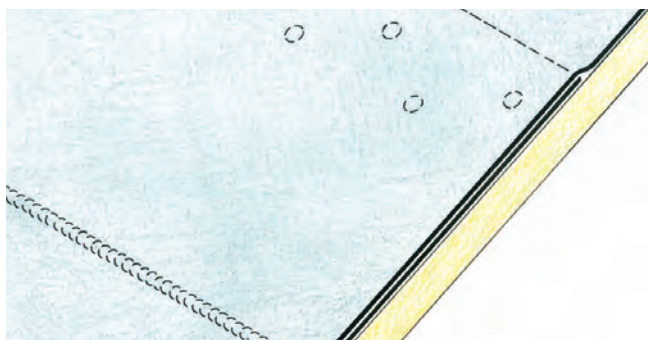
The courses currently available from the LSTA include:

Specialist Applied-skills Programmes (SAP) in Lead or Hard Metal (Level 2 and Level 3)

The LSTA has been appointed by CITB as the UK's sole provider of these courses. The courses are a mixture of attendance at the training centre and on-site experience and assessment. Each of these courses will take up to 18 months to complete including 30-days attendance at the LSTA centre.

SAP courses normally have four intakes a year and candidates will be required to attend for the initial week. Subsequent training days can be arranged to suit your needs.

Most of the cost of these programme is met directly by CITB. Much of the balance can be reclaimed by employers as grant once candidates have successfully completed the course.



LSTA's City & Guilds Accredited Programmes

These courses provide a natural progression for those who want to gain a recognised qualification in leadwork or hard metal craft. Three courses are available in each material for those wanting to acquire the skills and knowledge used in roofing, cladding and weathering applications. The Advanced-level courses are designed for those wanting to undertake heritage projects.

All these courses are approved CITB short-duration courses and grant funding is available for registered construction businesses.

The courses are:

- **Traditional Basic Leadwork Craft** (5-day course) – this course is also available as two 3-days courses covering bossing and welding alone
- **Traditional Intermediate Leadwork Craft** (35-day course – split into 4 modules each taking 5 to 10 days)
- **Traditional Advanced Leadwork Craft** (15-day course)
- **Traditional Basic Hard Metal Craft** (5-day course)
- **Traditional Intermediate Hard Metal Craft** (30-day course – split into 4 modules each taking 5 to 9 days)
- **Traditional Advanced Hard Metal Craft** (15-day course)

These courses can be taken on consecutive days or spread over a period to suit your needs.



Specialist Upskilling Programme (SUP) and On-site Assessment and Training (OSAT)

These options are designed for experienced workers without formal qualifications who want to obtain recognition of their skills by obtaining an NVQ Level 2 or Level 3 qualification without the need to spend significant time on off-site training. A simple profiling exercise is carried out by an LSTA Assessor to determine whether you have the skills to go straight to OSAT or will need a few days (usually between 5 and 13) formal tuition at the LSTA training centre. Once the assessor is confident you are likely to have the necessary experience they will arrange to visit you on site, probably two or three times, to see you using your skills to demonstrate you are competent to deliver lead or hard metal work at the appropriate level for the qualification you are seeking.

Bespoke Training

LSTA can offer bespoke training in lead and hard metals to meet your specific needs. This training can be delivered either at our Training Centre or we can discuss the options for bringing training to your workplace or a facility near to your location.

Choosing the right course, fees and timings

More detail on the content of each of the courses offered by LSTA is available on the website, as are details of fees and potential grants available.

The Training Team is on hand to provide advice and guidance on the most suitable courses and to speak to someone or to book a place you can contact the LSTA on 01622 87243 or by email info@leadsheet.co.uk



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Note: Details of adjacent structure and materials in this manual have been shown to ensure that the correct design and fixing of leadwork is illustrated. These details are of a generalised nature – for specific advice on components and materials other than Rolled Lead Sheet to BSEN 12588, contact the relevant manufacturers.

INTRODUCTION

Lead sheet is indisputably one of the great building materials. For centuries, it has been used to cover the roofs of cathedrals, churches and public buildings and there are countless applications of lead sheet on houses and offices throughout the UK.

When detailed and fitted correctly, lead sheet has been time-tested to prove its outstanding durability even in severe weather conditions.

Lead sheet is an ideal material for flashings. It can be readily cut and fitted with simple hand tools, while its extreme malleability makes it the most appropriate material for dressing over complicated shapes, particularly the multi-curved contours of many roofing tiles. Lead sheet is also suitable for modern roofing and cladding, as well as for the renewal of roof coverings and weatherings on old and historic buildings.

GENERAL INFORMATION

Physical properties of lead

Table 1. Physical properties

Atomic weight	207.2u
Atomic number	82
Density	11.34g/cm ³
Coefficient of linear expansion	0.0000297 per °C
Thermal conductivity	34.76W/m°C
Melting point	327.4°C

Mechanical properties of lead

Malleability

Lead is the softest of the common metals and its refined form can be easily manipulated with hand tools at ambient temperatures. Using the technique of bossing (see page 14), lead sheet can be worked into complicated shapes or dressed to fit the many types of deeply profiled tiles found in roofing. Generally speaking, periodic softening or annealing is not necessary, since lead sheet does not appreciably work-harden. However, when using the thicker grades of sheet in winter conditions, an application of heat along the fold lines and bossing areas will make the work much easier and reduce the risk of creasing the lead during bossing.

Fatigue and creep resistance

Lead is a metal of low strength, but provision is made for this in building applications by sizing and fixing the individual pieces of sheet so that the risk of fatigue cracking and creep is minimised.

Another factor that affects the strength of lead is its chemical composition. This is strictly controlled by BS EN 12588 to include very small amounts of other metals that manipulate the grain structure and make the lead sheet more resistant to thermal fatigue without affecting malleability.

‘Creep’ is the tendency of metals to stretch slowly over the course of time under sustained loading. However, experience has shown that significant creep will not occur with external leadwork if the pieces are sized to the recommendations in this book. The term ‘creep’ should not be applied to the slipping of lead down a pitched roof or vertical wall where the fixings have failed to give adequate long-term support.

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. 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.

Lead sheet – Specification

Lead sheet for all purposes should conform to BS EN 12588 Rolled Lead Sheet for Building Purposes. This specifies thickness and chemical composition to produce a consistent microstructure that provides the required resistance to creep and thermal fatigue. BS EN 12588 identifies a range of six thicknesses defined in millimetres. The specified thickness should not vary by more than $\pm 5\%$ throughout the sheet. For easy identification, these thicknesses have code numbers: 3, 4, 5, 6, 7 and 8. Thus the substance of lead sheet is specified by its BS code number or, alternatively, by its thickness in millimetres. The standard range of thicknesses, uses and maximum recommended sizes are shown in Tables 2 and 3. This Code of Practice only applies to fitting of the Rolled Lead Sheet manufactured to BS EN 12588. If you are using any other type of lead sheet please refer to the individual manufacturer for guidance on the installation

Lead sheet – Design considerations

Durability and thickness

Proof of the durability of lead can be seen on countless historic buildings and ordinary homes throughout the UK. Lead sheet is extremely resistant to corrosion by the atmosphere in urban, rural and coastal areas – generally speaking, the thinnest lead sheet will outlast almost any building as far as atmospheric corrosion is concerned.

Code 4 lead sheet is the minimum thickness to use for flashings, roofing, cladding and weatherings. However, the thickness will depend primarily on the size of the piece of lead sheet. Guidance on thickness for the various applications is given on page 2 and throughout this book. To achieve durability, however, additional thickness is

required to cope with thermal movement, which in turn depends on the size of the sheet.

Other factors that have to be taken into account when specifying thickness are allowances for bossing or dressing into deep profiles, such as over glazing bars or tiles; vulnerability to wind uplift; possible mechanical wear due to foot traffic (for example, during maintenance); and the quality of the building. On most historic buildings and in positions of extreme exposure, thicker codes are normally specified.

Although lead sheet is known to be a durable building material, there are nevertheless situations where precautions need to be taken (see 'Contact with other materials', pages 10 -11, and 'Resistance to corrosion', pages 4-5).

Thermal movement

Most lead sheet used in building is fixed externally and thus subjected to considerable changes in temperature. The coefficient of linear expansion for lead is 0.0000297 for 1°C, and it would be quite common in the summer, where the lead is heated by the sun, for it to vary in temperature daily by 50°C. Therefore, a 2m length of lead sheet could increase by 2m x 50 x 0.0000297, or about 3mm.

When considering the maximum amount of thermal movement during the course of a year, it is worth noting that the surface temperature of lead in a sun-trap situation, or a position that receives reflected solar heat from an adjacent light-coloured surface, can reach 90-100°C. The same piece of lead sheet will often drop to several degrees below freezing point in the winter months. Therefore, the maximum thermal movement of the 2m piece would be about 6mm. Making allowance for this movement is particularly important when detailing clips along the free bottom edge of pitched roofing and cladding panels (Figs 43-48, page 28-30).

Many flashings are also secured into a wall by lead wedges, or nailed along one side, and this restriction of thermal movement necessitates the use of regular expansion joints. For flashings, the expansion joints are usually laps and, to minimise the thermal movement at each lap, it is important that each individual piece of

flashing is no longer than recommended, as shown in the relevant tables.

If expansion (and subsequent contraction on cooling) of a piece of lead sheet cannot take place freely, there will be a risk of distortion and a concentration of alternating (fatigue) stress which, over a period, can cause the lead to crack. It is therefore of primary importance with lead sheet fixed externally to limit the size of each piece so that the amount of thermal movement is not excessive, and to ensure that there are no undue restrictions on this movement. Recommendations on sizing and fixing of lead sheet for various applications are given throughout this book.

Thermal Insulation

The conductivity of lead is 34.76W/m²/°C and for practical purposes the effect of lead cladding or roofing can be ignored when calculating thermal resistance.

Resistance to fire

Lead is incombustible but melts at 327.4°C. Lead roofs achieve the following ratings when tested to BS 476: Part 3 (current at time of publication):

- (a) Lead laid on square-edged boarding: BA
- (b) Lead laid on tongue-and-groove boarding or concrete: AA

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

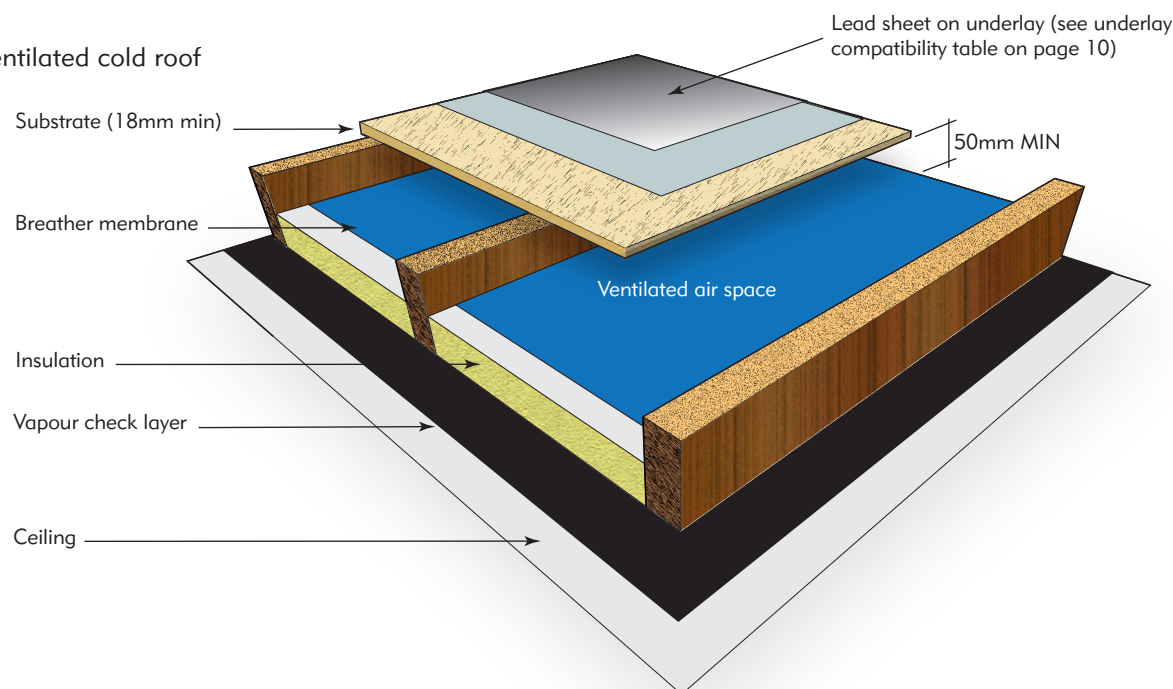
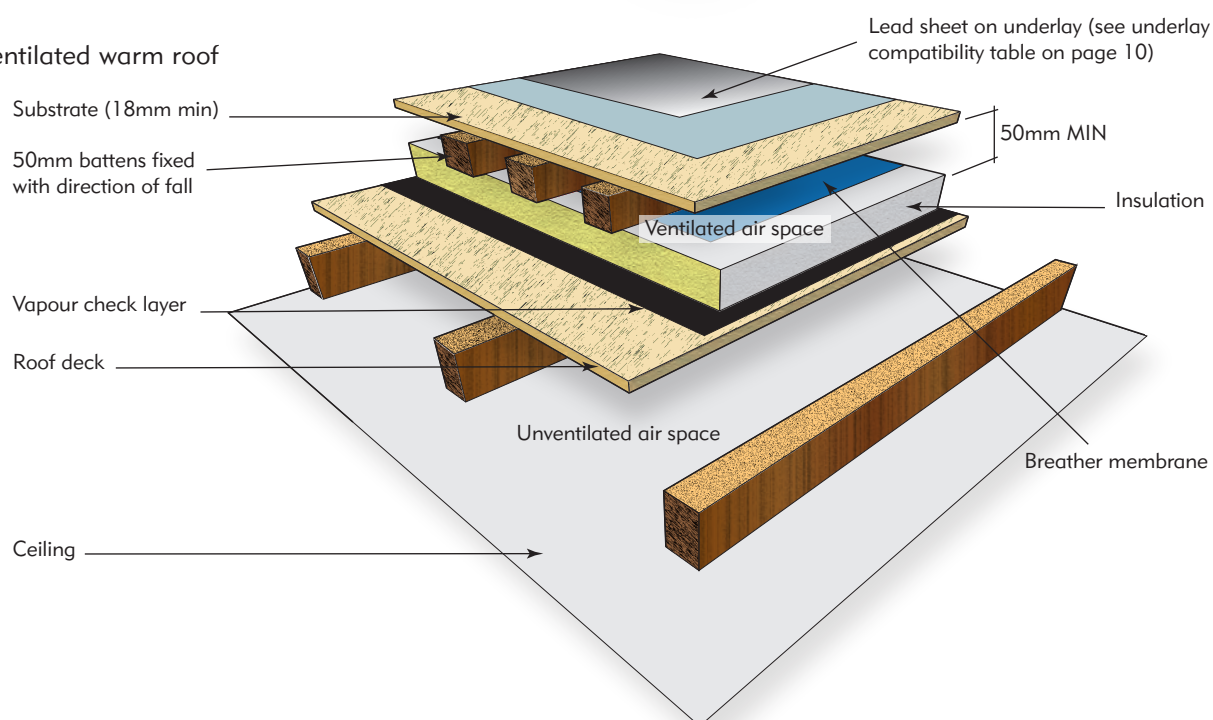
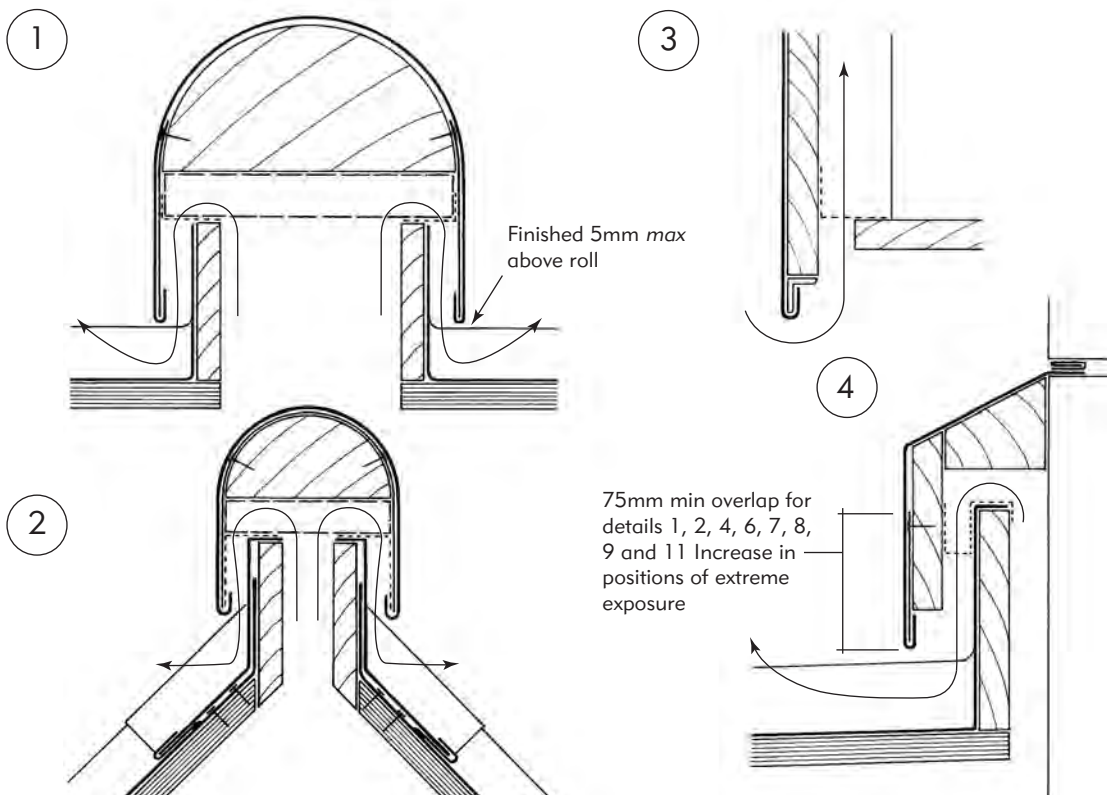
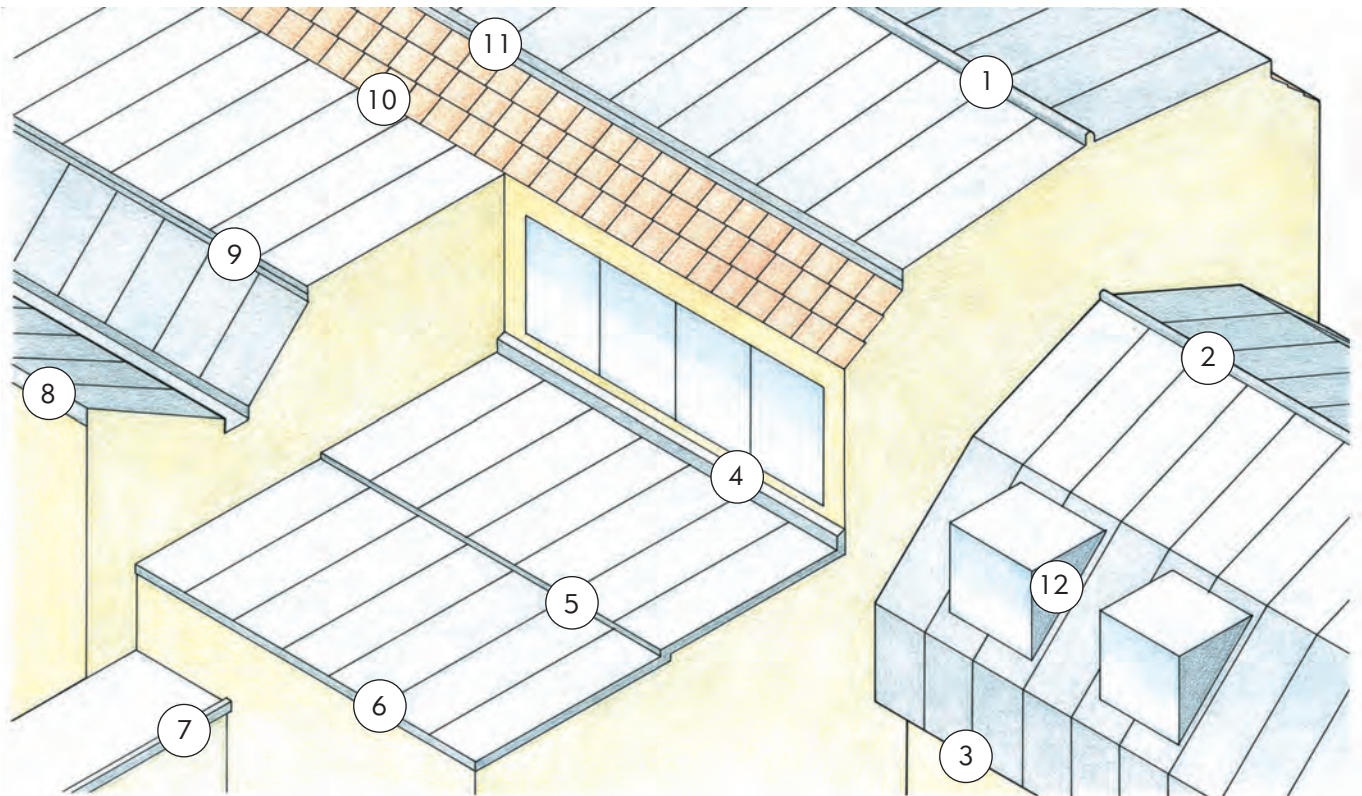


Fig 1b. Ventilated warm roof



Ventilation details

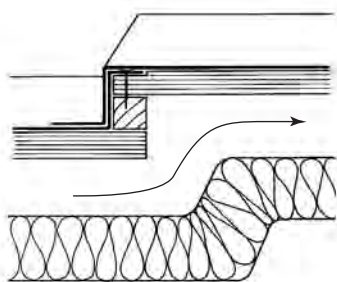
Key drawing and ventilation details



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).

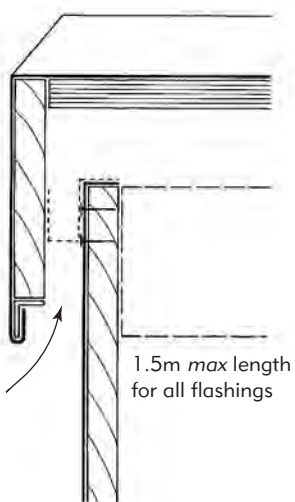
Ventilation details (cont.)

5

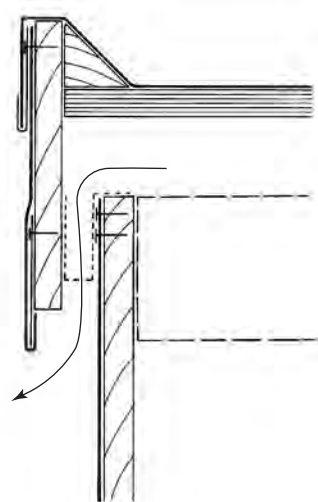


All leadwork to standard details

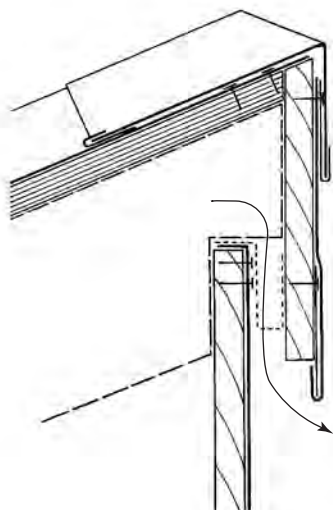
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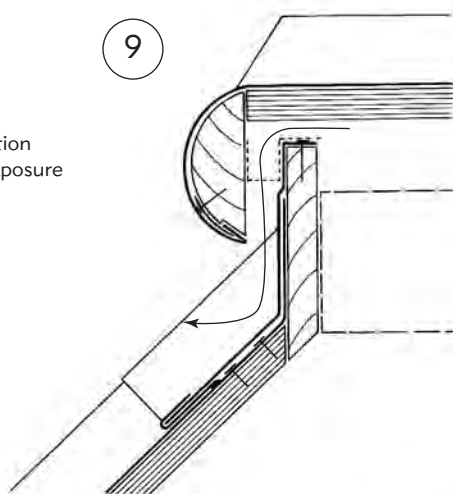


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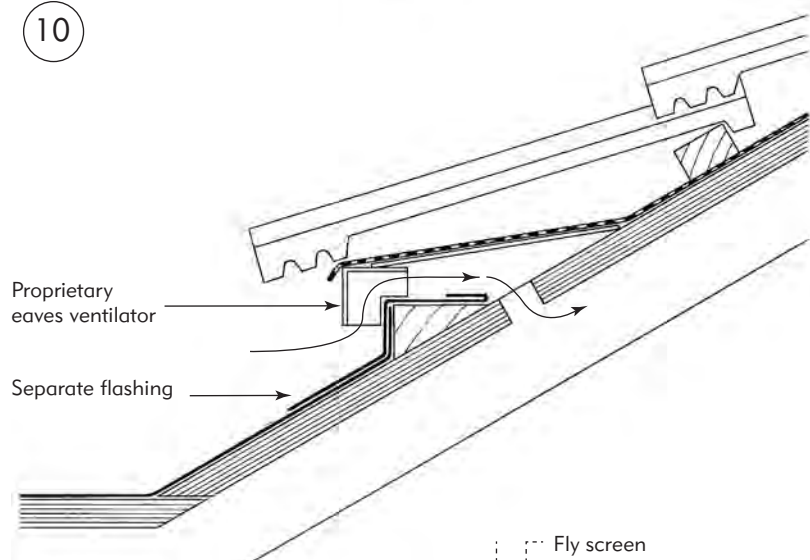


All free edges of ventilation details clipped to suit exposure

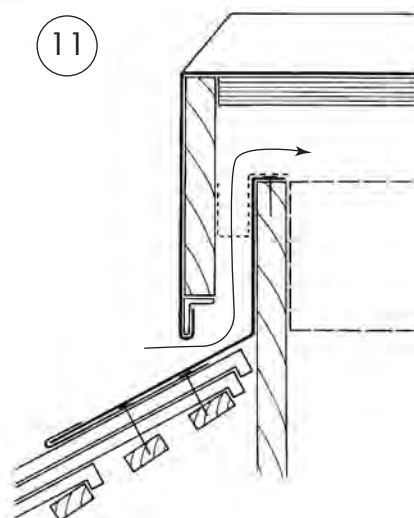
9



10



11



Fly screen

Ventilation gap - refer to British standards

12 Dormer cheek ventilation

Battens to form 25mm minimum ventilated air space

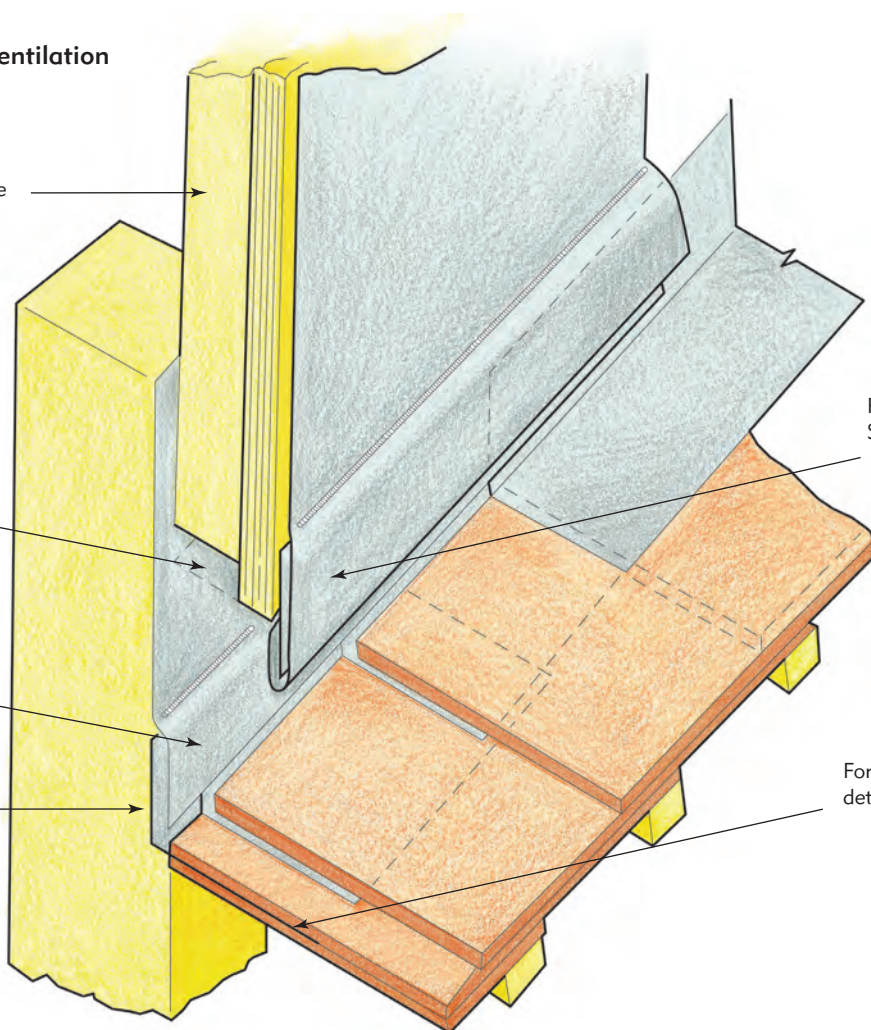
Fly screen protecting ventilated area

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.

Underlays (cont.)

Recent research into the use of building papers has shown that they perform well but must be fitted over the whole substrate area. They are particularly suitable for use with plywood that may contain certain aggressive substances. It may also be used to reduce the risk of corrosion to lead when laid on oak (see 'Timber', page 11).



Geotextile underlays (200-220g/m2)

Needle-punched non-woven geotextile underlays do not rot or cause adhesion to the lead sheet, which would restrict thermal movement. It is recommended that they are only used on existing or new timber boards when fixed with penny air gaps which allow ventilation from below the substrate to the underside of the lead sheet. This provides the necessary conditions for the formation of stable patina.

They are not deemed suitable for use with exterior quality plywood for construction purposes, concrete, brick or stone because any moisture in these materials could be aggressive to the lead sheet and cause the underlay to act like a sponge which may remain wet between the lead sheet and the substrate.

Breather Membranes

Breather membranes are designed for use in conjunction with vapour control laminates to protect insulation from draughts and build-up of dirt and moisture that can reduce its efficiency. **They are not suitable as an isolator between the lead sheet and the substrate.**

Other materials



Felts and membranes made from other materials are often offered as being suitable for use under lead sheet. These should be cautiously considered in respect of the principles described previously before being specified.

An unsuitable underlay may cause the lead to buckle and split, even where the panels are not oversized or over-fixed. Materials with a bituminous surface, or with certain bonding agents, can become sticky in hot weather and cause the lead to bond firmly to the substrate. This restrains normal thermal movement of the lead sheet and failure could occur within a few years.

Fitting underlays

Whatever type of underlay is used, lead sheet should be laid on a dry substrate and underlay. If moisture is trapped between the lead and the substrate, some corrosion may occur for a time, even where ventilation has been provided. Timber treatments that are still wet prior to being covered in lead sheet may cause deterioration of both the underlay and the lead sheet. Underlays should be laid in strips across the fall of the roof, lapped and stapled into position. An upturn against any abutments is advisable but the underlay should not drape over the edges at the verge or eaves, as this may draw moisture into the substrate by capillary attraction. Where wood-cored rolls are used, they should be fitted over the underlay.

Some sarking felts commonly used for roofing may also adversely affect lead sheet. Moisture might become trapped under lead sheet that could result in underside corrosion.

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.

Contact with other materials – Timber

Dilute solutions of organic acids from hardwoods, particularly oak, can cause lead slowly to corrode. This corrosion can be exacerbated in situations where condensation forms below roofing and cladding, and takes up acid from the substructure. This potential problem, which is usually associated with old and historic buildings, can be controlled by adequate ventilation and the use of a building paper underlay.

Investigation has shown that impregnation of softwoods with preservative and fire-retardant solutions does not, in itself, increase the risk of corrosion. However, it is important to ensure that the substrate is dry before the lead sheet is laid.

There are organic acids in cedar and oak roofing shingles that can form a dilute acid solution with rainwater; this will slowly corrode the leadwork onto which it runs. In this situation, it is advisable to protect the lead with a coating of bitumen paint for a few years, during which natural weathering of the shingles will leach out the free acid.

Similarly, hardwood that is laid over lead flashings – such as window sills – can cause corrosion but, again, this can be avoided by coating the lead with bitumen paint before the hardwood is fixed. Alternatively, thicker lead could be used, which would allow some attack to occur without greatly reducing the expected service life.

Contact with other materials – Sealants

Sealants are often used to seal the joint between lead sheet and other building materials. Suitable sealants are either polysulphide or silicone. Silicone can accommodate greater movement than polysulphide and is available in two forms: acid cure and neutral cure. It is important to use only neutral cure silicone with leadwork because acid cure can cause a white corrosion product to form on the surface of the lead.

When using a sealant to point the joint where lead is turned into a chase in brickwork or masonry, the manufacturer should be consulted to ensure that the polysulphide or silicone is suitable for the purpose and compatible with the masonry and DPC material.

Mastic sealants are not recommended for jointing pieces of lead sheet together.

Contact with other materials – Masonry, concrete and mortars

Concretes and mortars made from Portland cement or lime can initiate a slow corrosive attack on lead in the presence of moisture. Direct contact between lead and new concrete or mortar should therefore be avoided in situations where drying out and carbonation of the free lime, by reaction with atmospheric carbon dioxide, is likely to be slow. Lead sheet built into brickwork or concrete as a DPC or impermeable membrane should be protected with a thick coat of spirit-based cold-applied bitumen paint on both surfaces.

However, flashings turned into brick joints or chases in concrete by not more than 50mm do not need any protection because, in this situation, carbonation of free lime is rapid and no risk of attack then exists.

When lead claddings, roof coverings and weatherings are applied to concrete surfaces, a sealing coat of hard-drying bitumen paint on the concrete, together with an underlay, gives adequate protection during the drying-out period.

Resistance to corrosion – Lichen and moss on roofs

Slow corrosion of lead by dilute organic acids can arise where there is lichen or moss growth on slated or tiled roofs. The rainwater picks up organic acid from the growth and where it runs on to the lead it gradually forms grooves, which in time can penetrate the lead covering. Below drip-off points, such as along a slated roof over a gutter lining, the acidic rainwater causes circular corrosion areas. After many years, this corrosion can penetrate through the lead.

The rate of corrosion on lead is very slow and is not usually a problem in domestic flashing applications. In situations where areas of roof covered by lichen discharge into lead-lined gutters, the problem can be avoided by fitting lead sheet sacrificial flashings (see 'Gutter linings', page 99). Alternatively, a solution can be applied to the roof that will kill the lichens and mosses and prevent regrowth for a considerable time.

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

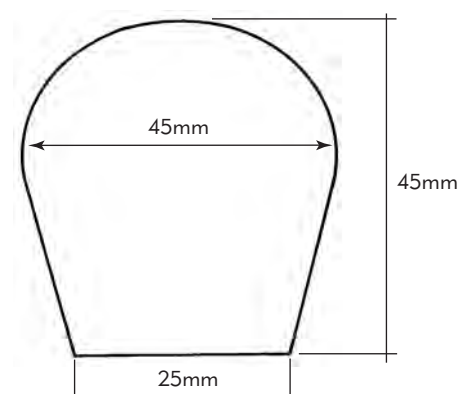
Where battens are used for fixing leadwork to concrete, brickwork or blockwork, they should be of treated softwood to protect them from rot, and should have the following minimum dimensions:

- 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



WORKING METHODS

Bossing

The technical term 'to boss' was in use in the Middle Ages to describe the beating out of metals into shapes. Bossing in this sense came to be applied to the general shaping of malleable metals. Leadworkers now use the term to describe the shaping of lead sheet with hardwood hand tools – traditionally made from boxwood, lignum vitae and sometimes hornbeam, holly and beech. Similar tools made from a tough plastic are also available and are found to be an acceptable alternative.

Lead is the softest of the common metals. Most importantly, it does not harden significantly when worked, being quickly self-annealing at ambient temperatures. Thus, lead can be readily shaped by bossing without the application of heat, and without cracking or becoming hard and brittle.

Bossing, like other manual skills, must be learned from an experienced instructor and much practice is required to achieve the standard required for competent leadwork. Good bossing is achieved when the lead is worked to the required shape without creases or cracks and without reducing the thickness of the lead sheet by more than 25%. In bossing, there can be a surplus of lead to be bossed out and cut away or a shortage that has to be provided for when setting out the work so that the risk of thinning can be avoided.

The range of tools used for bossing lead sheet and dressing it into position is shown in Fig 3. These tools are made in various sizes to suit the thickness of lead sheet to be worked. Guidance on bossing various details is shown throughout this manual.

Fig 3. Tools for bossing

Flat dresser – required for dressing lead sheet flat, both when setting the work out and when fitting it in position

Bossing stick – the original tool used for bossing lead sheet

Bending stick – originally intended for bending lead pipe, this tool is often used by leadworkers for bossing

Bossing mallet – some bossing requires the use of two tools together, which are the bossing mallet and the bossing or bending stick

Setting-in stick – primarily used by being struck with a mallet to set in lines of folds prior to bossing, but may also be used to finish leadwork in position

Chase wedge – also struck with a mallet for setting-in, but its main use is for finishing leadwork in position. In using this tool to finish leadwork, care must be taken not to drive it too hard and thereby cut deep into the lead

Welding

Traditionally the welding of lead has been known as lead-burning. Lead-welding is widely used as an alternative to bossing and is preferred for situations where bossing is likely to result in unacceptable thinning of the lead sheet – for example, when making a break corner (Fig 195, page 113).

Lead-welding, like bossing, is best learned from a skilled instructor. Therefore, the following notes and diagrams are intended only as a basic guide to the general principles involved. However, once these are understood and the basic techniques practised to attain manual dexterity, there should be no difficulty in achieving a standard suitable for all situations where lead-welding is required.

In fabricating lead components, the work should be arranged so that the welded seams can be made in the easiest position (for example, flat supported seams in preference to upright seams). Usually this can be achieved by turning the component on the bench. When welding in-situ, it is often possible to weld a seam in a flat supported position before the work is folded down. For all positions, it is important that the surfaces or edges of the lead to be welded are in close contact. Further details for welding lead sheet are shown throughout this book.

Basic principles for welding

Good lead-welding is achieved by observing the following basic principles:

Clean surfaces

It is essential that the meeting edges and faces of the lead are clean, including the underside meeting faces of lap joints. With new lead sheet, the surface may not require cleaning. However, with sheet that has been stored for some time, and certainly when repairing existing leadwork, it will be necessary to clean the weld areas with a shave hook. No flux or tallow should be used for lead-welding.

Correct penetration

With flat butted seams, the weld should fully penetrate through the thickness of the lead sheet (Fig 4a). For lapped seams, the weld should penetrate the surface of the lead but should not penetrate through to the underside (Fig 4b).

Correct thickness

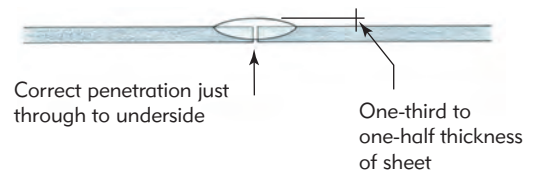
The thickness of a lead-welded seam should be between one-third and one-half thicker than the lead sheet.

Weld width

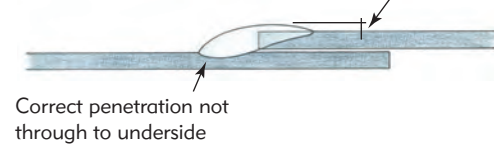
The width of a weld will depend on the thickness of the lead sheet, the type of seam and the number of

Fig 4.

a. Butted seam



b. Lapped seam



loadings. When using code 4, the minimum width of a flat butted seam should be 10mm, and this will increase for the thicker codes and when using lapped seams (for example, a code 8 lapped joint with two loadings would be about 25mm wide).

Although there is no set width for a weld, for aesthetic reasons each type of seam should be as near the same width as is practical throughout a leadwork contract. To achieve this will require careful supervision, especially where several welders are working on the same job.

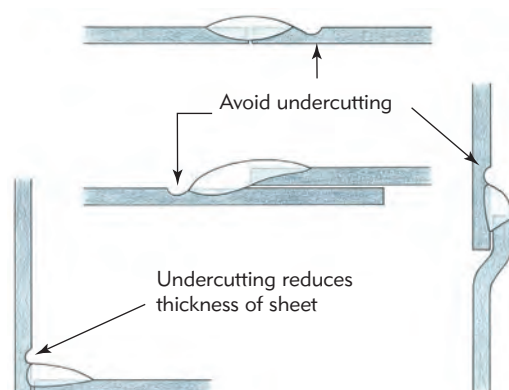
Avoid undercutting

Reducing the thickness of the lead at the side of a weld (undercutting) must be avoided because it creates a weakness in the sheet that can result in cracking along the weld line (Fig 5). Undercutting is usually caused by holding the flame for too long in the molten pool and using an inadequate amount of the filler rod.

It can also occur when welding outdoors in windy conditions. The wind tends to blow the heat to one side of the weld area, but the problem can be avoided by turning the flame slightly towards the direction of the wind.

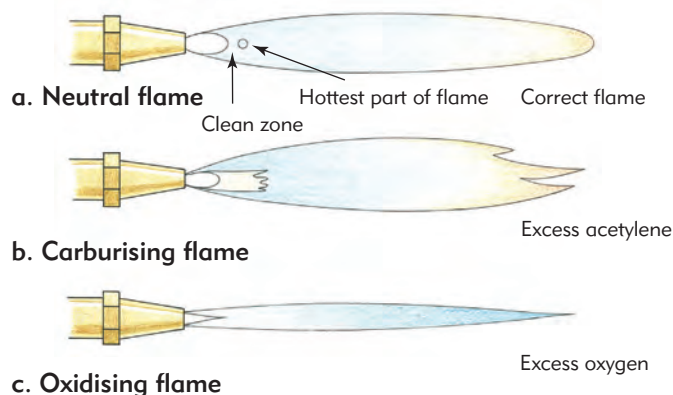
Inclined and vertical seams are particularly prone to undercutting. This is mainly due to holding the flame for too long on the vertical surface.

Fig 5. Undercut seams



Welding (cont.)

Fig 6. The oxy-acetylene flame



Correct flame

Although hydrogen and propane can be used in combination with oxygen for lead-welding, the gases normally used for building work are oxygen and acetylene. Portable equipment is now in common use, making in-situ work far easier than in the past.

Oxy-acetylene flame

For lead-welding with oxy-acetylene, a pressure of 0.14 bar (2lb/sq in) on the gauges of both gas cylinders is suitable for most seams, although some experienced welders prefer slightly higher pressures when using the larger nozzles for welding thick lead sheet. A small blowpipe is used for lead-welding, with interchangeable nozzles numbered from 1 to 5. When correctly adjusted, the working part of the blowpipe flame is immediately in front of the small cone at the tip of the nozzle. The temperature at this point is far in excess of the melting point of lead.

When lighting the blowpipe, the combustible gas (acetylene) is turned on first, followed by the oxygen, to produce a clean neutral flame (Fig 6a). Care must be taken to avoid an excess of acetylene that will give a carburising flame (Fig 6b), or an excessive proportion of oxygen that will produce an oxidising flame (Fig 6c). Both of these flames are unsuitable for the welding of lead sheet.

Reference is made in this chapter to fast and slow flames. A fast flame occurs when the nozzle size and flow of gases to the blowpipe produce a flame that creates a fast weld progression to avoid over-penetration. When using a slow flame, the weld progression is slower and there is more control over the weld. Experienced welders use fast flames for flat supported butt and lapped seams but, for most in-situ work, particularly when welding inclined and upright seams, a slow flame is usually more appropriate.

The size of nozzle to use for welding with oxy-acetylene equipment will depend on the thickness of lead sheet, the type of seam and the experience of the welder. In general, nozzle sizes 2 and 3 are used for welding codes 4 and 5, and sizes 3 and 4 for codes 6, 7 and 8. With upright seams, sizes 1, 2 and 3 are normally used, depending on the thickness of lead.

Safety precautions

Full instructions on the use of gas cylinders and equipment and on safety precautions are supplied by the manufacturers and should be rigidly observed. It is important that equipment designed for oxy-acetylene should be used only for that gas mixture. When working in a workshop or confined space, it will be necessary to wear a suitable mask or provide mechanical ventilation of the weld area, particularly in a workshop. Reference should be made to the current regulations and health and safety literature.

Jointing methods

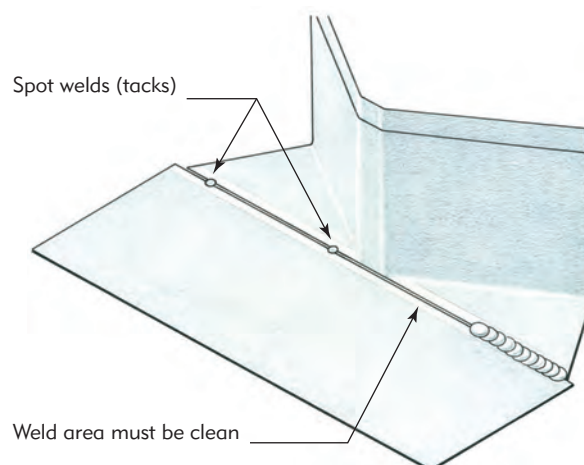
Lead-welded seam

The pieces of lead sheet are usually held together by spot welds (tacks) to prevent movement and to keep the meeting faces in close contact while welding the seam. Welding rods, sometimes referred to as filler strips, are cut from lead sheet. Alternatively, extruded lead rod up to 6mm in diameter is available from lead suppliers. The composition of the welding rods should be the same as the lead sheet and it is important that the welding rod, like the meeting surfaces of the sheets to be welded, is clean.

Flat butted seam

This seam is used for joining pieces of flat supported lead sheet (Fig 7). The edges of the pieces should be in close contact, shaved clean if necessary and then spot-welded.

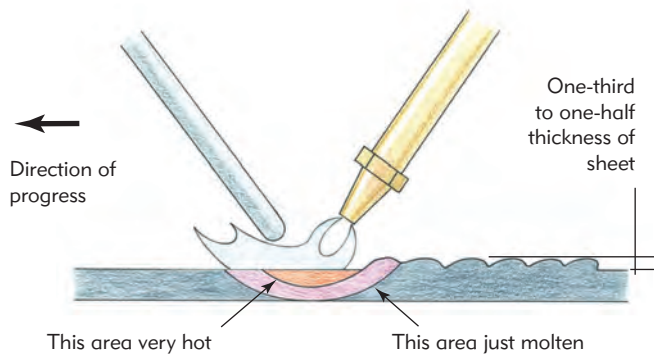
Fig 7. Flat butted seam



Welding (cont.)

Fig 8 shows the position of the blowpipe and filler rod in making the seam. Note that the tip of the cone of the flame is just clear of the surface of the molten lead. Lead is melted off the welding rod into the weld area to build up a seam to between one-third and one-half more than the thickness of the sheet.

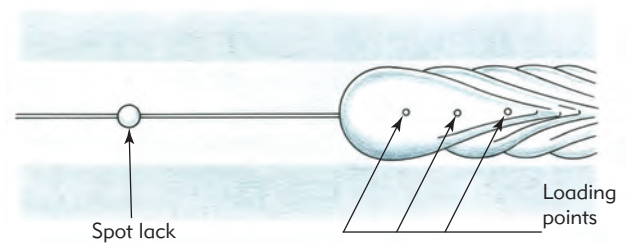
Fig 8. Position of blowpipe and filler rod



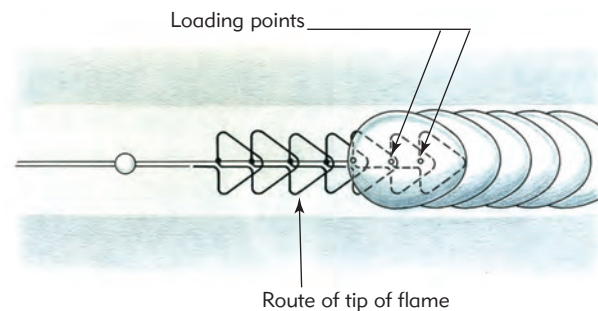
A good weld should penetrate just through to the underside of the lead with a width of not less than 10mm for code 4, increasing to about 20mm for code 8. The flame is directed into the centre of the seam and is moved forward, either in a straight line or slightly from side to side. This action and the speed of the forward progression will determine the pattern of the seam. If the aim is to achieve quick progression by using a fast flame, the flame is moved forward in a straight line (Fig 9a). This produces a seam pattern often described as 'herringbone'. When using a slow flame and progressing with a side-to-side action, the slower progression produces a rounder pattern (Fig 9b). This method of welding is usually preferred for in-situ work.

Fig 9. Seam pattern

a. Flat butted seam – straight-line progression

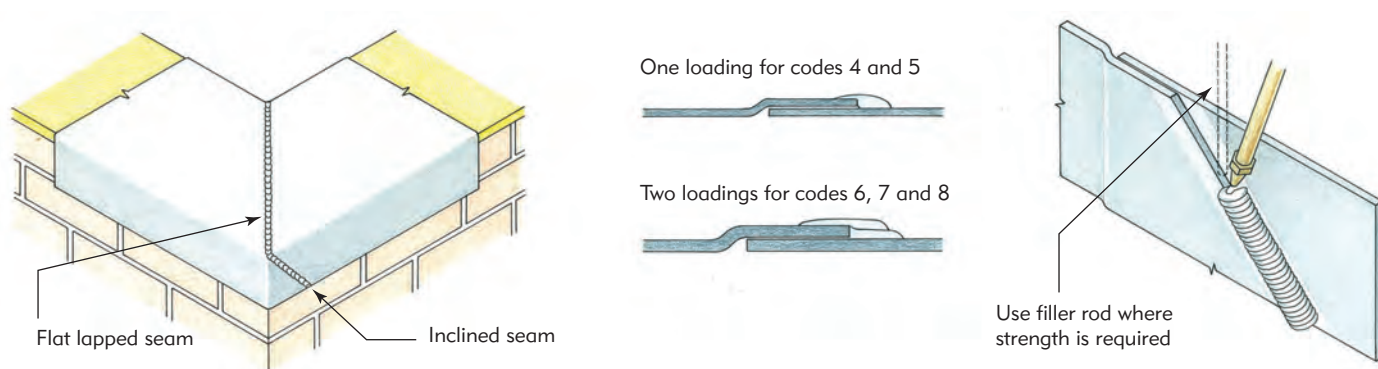


b. Flat butted seam – side-to-side progression



Welding (cont)

Fig 10. Flat lapped and inclined seams



Flat lapped seam

The use of this seam as an alternative to the flat butted seam is often preferable for in-situ work. It is also recommended for all situations where there is a risk of fire when using the butt joint (see 'Hot working with lead sheet', pages 19-20). Fig 10 shows an example of a joint in a parapet capping where a lapped seam should be used when welding in-situ over a timber substrate. The lap should be 20-30mm depending on the thickness of lead sheet used for the work. The method of welding is similar to the butted seam, except that with codes 6, 7 and 8 it is necessary to use two loadings to achieve a strong weld.

Inclined seam on vertical face

Fig 10 also shows an example of where an inclined seam would be used. The lap allowance is similar to the flat lapped joint, but for all thicknesses of lead, only one loading is required. Although this joint can be made without a filler rod by using the overlapping edge to make the seam, it will be relatively weak. Therefore, where strength is important (for example, when welding gussets into internal break corners), the use of a welding rod to strengthen the seam is recommended. To avoid burning through the underlapping sheet, a slow flame is used to weld this joint.

Upright seam

In most cases, careful arrangement of the leadwork will avoid the need for upright welding. However, where it is necessary, the lead is lapped as shown in Fig 11a, and the edge of the overlapping sheet is progressively fused to the underlap by the controlled movement of the flame. The exact method of achieving an upright seam varies with each welder. An upright seam can be made without a welding rod, but to achieve a strong weld, the use of a filler rod is recommended.

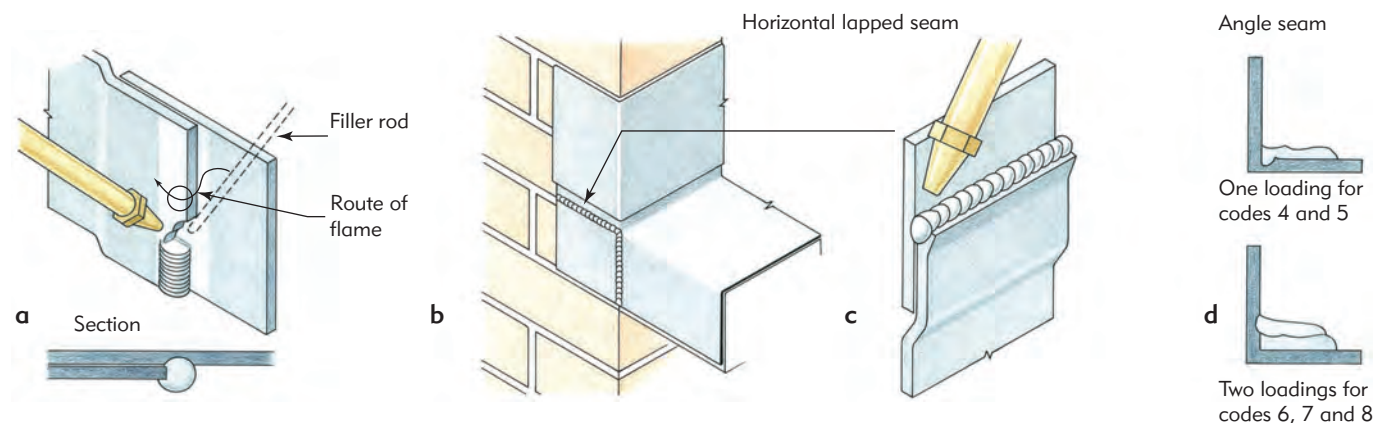
Horizontal lap seam

An example of a horizontal lapped seam is shown in Fig 11b. The overlap can be turned out slightly to form a small channel and a single loading is usually adequate for this seam (Fig 11c).

Angle seam

For an angle seam, it is possible to use one loading for codes 4 and 5 lead sheet but two loadings will be needed when using codes 6, 7 and 8 (Fig 11d).

Fig 11. Upright seam



Hot working with lead sheet

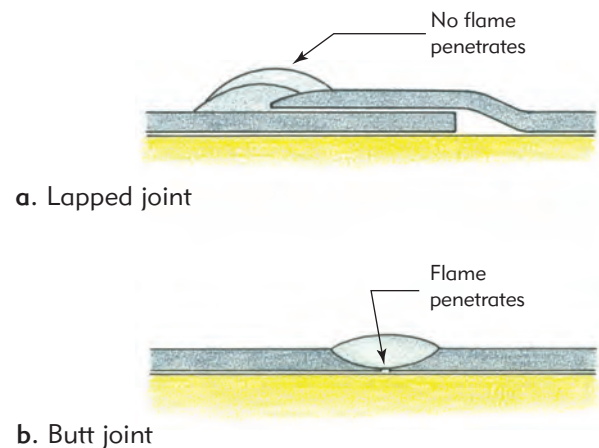
Heat is sometimes necessary if bossing takes place in cold weather when using thicker codes of lead sheet. Where certain details are too difficult or complex to boss, lead sheet may have to be cut and welded (lead-burned) to form the required shape. Also, some leadworkers prefer to weld lead sheet as this avoids thinning out, and in the hands of a skilled operator it is usually quicker than bossing, although it lacks the smooth finish characteristic of bossed details.

Roll ends, corners, back gutters, front aprons, clips on sheet and catch pits should usually be welded out of position. However, repair patches, intermediate fixings, flexible gutter joints, built-in catch pits and ornamental details can only be welded in-situ, in which case precautions should be taken against the minimal risk of fire.

When lead-welding in-situ over a combustible substrate, there is a risk of fire if the flame is able to penetrate through the joint. In many cases (for example, forming of roofing and gutter sections, flashings etc), it is both possible and practical to preform and weld the lead out of position (that is, on the bench). This avoids any risk of fire. However, where in-situ welding is necessary, the lap joint should be used because this method of welding avoids the risk of flame penetration to the substrate (Fig 12a).

Where a butt joint is welded in-situ over a combustible substrate, there is always a risk of fire because the flame can penetrate through the joint (Fig 12b). If the use of an in-situ butt joint is unavoidable, the risk of fire can be greatly reduced by wetting the timber immediately below the weld area. When the weld is finished, the damp substrate will be readily dried by ventilation and solar heat. An alternative is to slide a piece of non-combustible material under the butt joint, which can

Fig 12. Welded joints



be removed after welding. This method should also be used if there is any risk of penetration when welding inclined and upright seams in position.

Lap joints should always be used when repairing leadwork on older buildings and when repairing new leadwork that has been accidentally damaged. An assistant to the operative should always be in attendance when welding over combustible substrates, and particular vigilance is essential in high wind conditions. Fig 13 shows a summary of the recommended precautions during and after lead-welding operations.

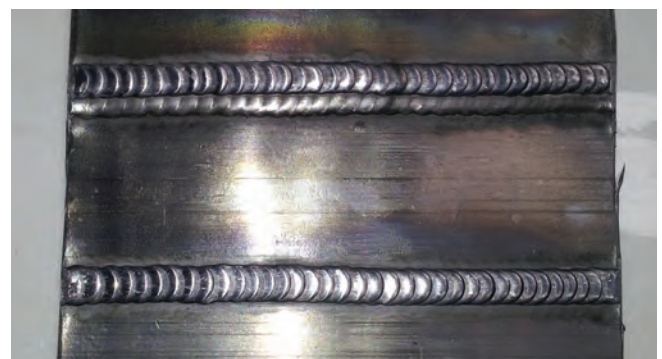
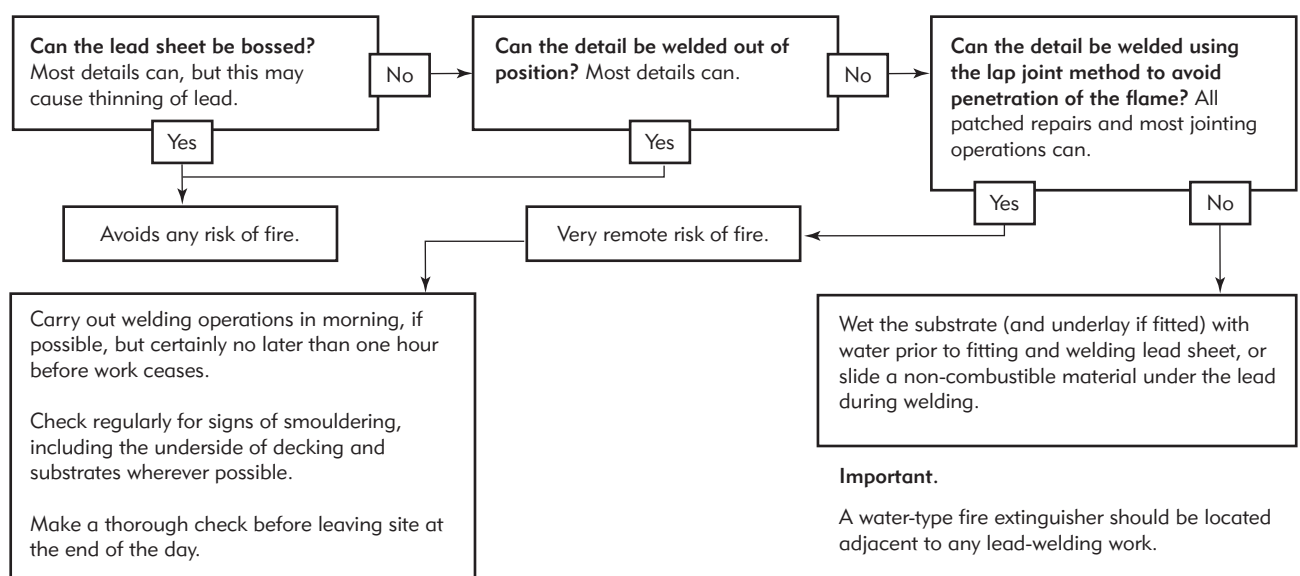


Fig 13. Fire precautions



Hot working with lead sheet (cont.)

Precautions

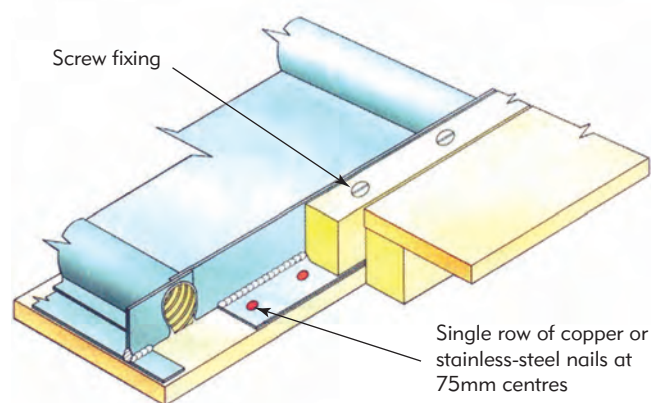
These precautions are usually enforced by the use of a "hot work permit" scheme that is applicable to all types of buildings. The hot work permit provides a certain amount of control through a series of checking procedures during and after the welding process. It also contains a comprehensive list of relevant precautions. These include:

- Spray water under the work prior to welding
- Use lap joints to avoid flame penetration
- Never leave a lighted torch unattended
- Keep two fire extinguishers available close to the work
- Make regular checks during and after lead-welding. Complete the work at least two hours before the site is closed for the day
- Make a thorough check before leaving site at the end of the day.

Other options

There are alternatives to in-situ hot working that could be considered. For example, there is a suitable alternative to welding over head fixings where lead is laid on roofs pitched between 3 and 10°. An example of this type of detail that can be adapted for drips, ridges and abutments is shown in Fig 14.

Fig 14. Alternative details for head fixing



The use of adhesives

The LSTA does not normally recommend the use of adhesives for general leadwork. However, in situations where in-situ welding is prohibited, it may be the only practical alternative, particularly for the fixing of clips for heating tapes and lightning conductors, or the covering of fixings.

A range of adhesives is available for use with lead sheet. Care should be taken to follow the manufacturers' instructions. Because it is not possible to predict the service life of adhesives in the situations described, it is recommended that all leadwork where adhesives have been used be regularly checked.

Finish and quality of work

Bossing

Internal and external corners, roll ends (top and Bottom). Bossed details should have a smooth and even finish without creases or thinning of the lead sheet.

Welding

Internal and external corners, roll ends (top and bottom) and other welded details. There should be no pinholes in the weld or undercutting of the parent metal.

Quality of lead sheet

Rolled lead sheet to BS EN 12588 provides a uniform thickness within a tolerance of plus or minus 5% of stated thickness. It should be free from laminations and surface damage. Lead sheet should be stored in dry conditions prior to installation to prevent unsightly brown stains forming on the surface.

Surface finish of lead sheet

There may be bands or areas of rainbow colours, but this is normal and does not affect the life or performance of the lead sheet. They normally disappear as the lead weathers down. Due to the natural reaction of lead sheet to the atmosphere, the final surface patina may develop into differing shades of grey. Where an initial consistency of finish is aesthetically important – for example, in vertical cladding – the lead should be inspected for consistency of colour before and during installation. If patination treatment is to be applied, care should be taken to follow the manufacturer's instructions.

Protection of surfaces

Lead is easily damaged. Finished leadwork should be covered with a protective material, particularly where there is regular foot traffic or other work being carried out above.

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 LSTA.

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.

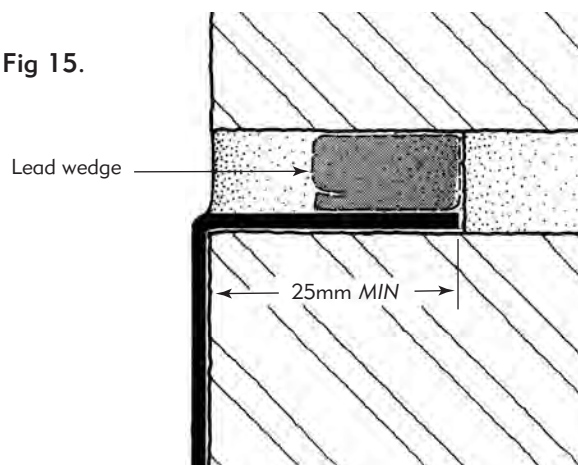
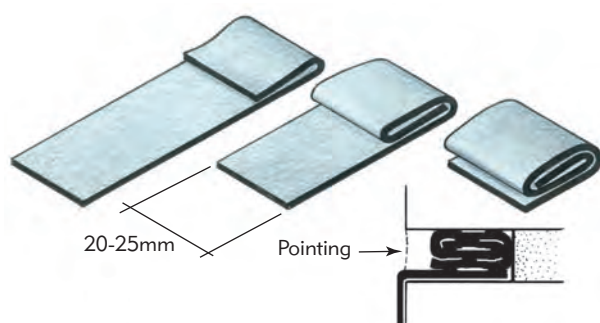


Fig 16. Wedges

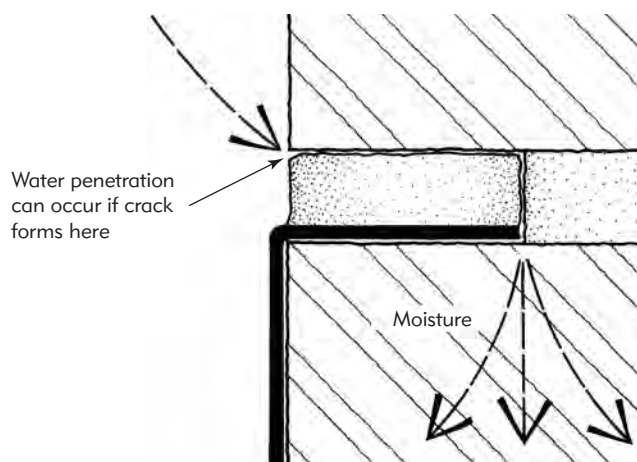


Lead flashings to brick and masonry walls without DPCs – Wedging, fixing and pointing (cont.)

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.

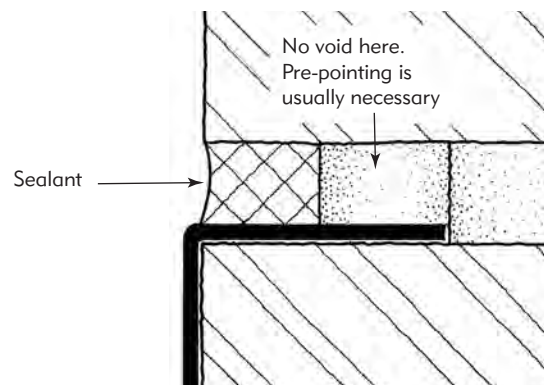
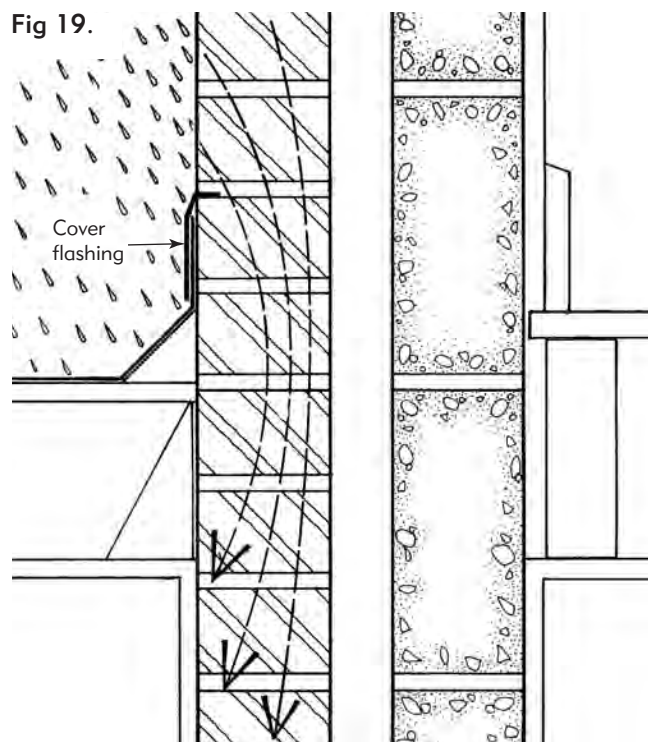


Fig 19.



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.)

Where a wall is to be rendered, or when cutting into an existing rendered or rough-cast wall, the abutment can be weathered using a lead flashing in conjunction with a galvanised or stainless-steel renderstop (Fig 20), which should lap the upstand of the lead by not less than 25mm.

For wide joints in stonework, it is usually not practical or aesthetically acceptable to use a sealant for pointing. In addition, experience has shown that lead wedges do not always provide a long-term fixing in wide masonry joints, particularly on older buildings where the corners of the stone have weathered away.

Fig 21 shows the recommended method of fixing lead flashings when the joint is more than 18mm wide. Each 1.5m length is turned up the back of the chase (raggle) and fixed by stainless-steel screws and washers at about 450mm centres. Mortar is used for the pointing, but to accommodate thermal movement it is essential to separate the lead from the mortar with the use of masking tape.

By thoroughly cleaning out the joints, wetting the masonry and using the correct mortar (well compressed into the joints), a good bond between the masonry and mortar can be achieved. Experience has shown that water does not penetrate through the hair's-breadth joint between masking tape and lead because of the vertical turn-up at the back of the joint. This practice is not suitable for the detail in Fig 16 because there is no turn-up.

Joints in concrete walls (Fig 22) are usually wide at the front to facilitate the removal of shuttering. In these cases, it is essential to separate the mortar from the lead with masking tape, but a more practical alternative for concrete walls is to point with a sealant, as shown. On old buildings, especially historic ones, however, sealants are rarely used for pointing very wide joints.

Joints in old masonry walls (Fig 23) are often very wide at the front due to weather erosion on the corners. Again, the use of masking tape to separate the mortar from the lead is important and, in some cases, it will be necessary to renew the joint as shown to achieve a good fixing.

Fig 20.

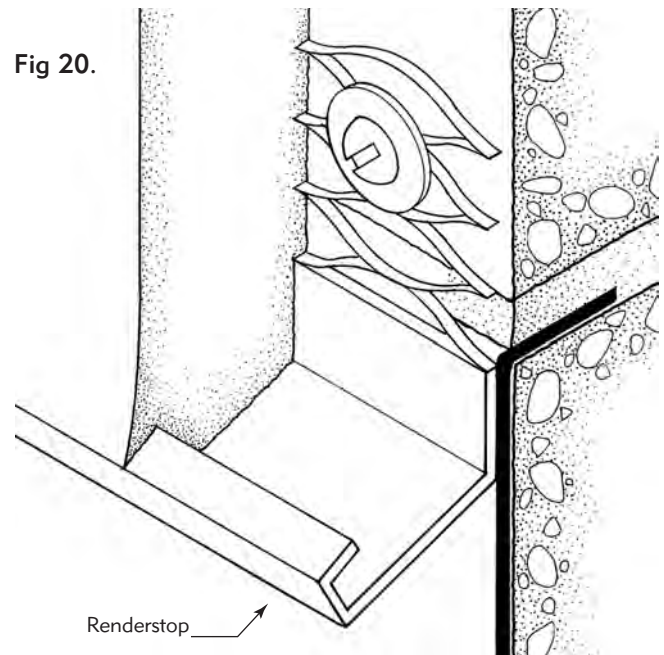


Fig 21.

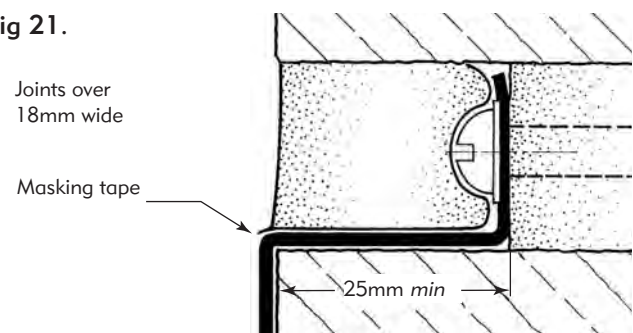


Fig 22.

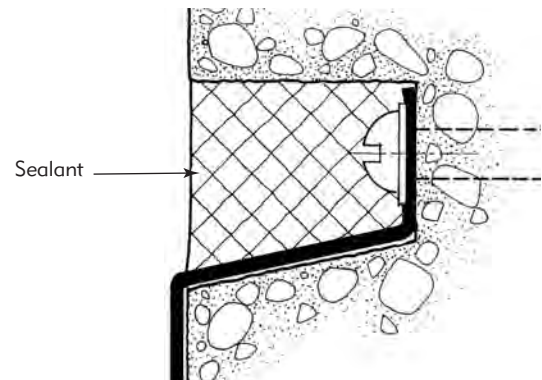
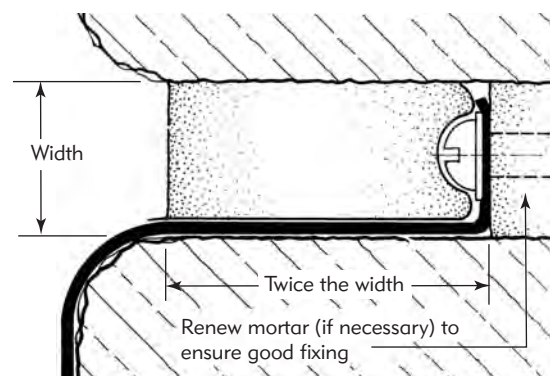


Fig 23. Very wide joints (old buildings)



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

Fig 24 shows a detail sometimes used with wide joints in masonry. This method is not recommended because (a) lead wedges rarely provide adequate fixing, especially if the corners of the masonry are worn, and (b) the mortar will always crack and water will be able to penetrate as shown.

With very thin joints, usually in stonework, it is not possible to successfully turn in a lead flashing, then wedge and point. In some situations, it may be possible to widen the joint (Fig 25), but in most cases, it will be more satisfactory to cut an independent chase as shown in Fig 26. With modern electric cutting discs, it is possible to cut chases from about 10mm wide, and therefore the joint detail can be either as shown or as in Fig 27.

Note that, when using cutting discs to remove mortar from existing joints, it is essential to remove all of the mortar, otherwise there will be a risk of water penetration (Fig 28).

Fig 24.

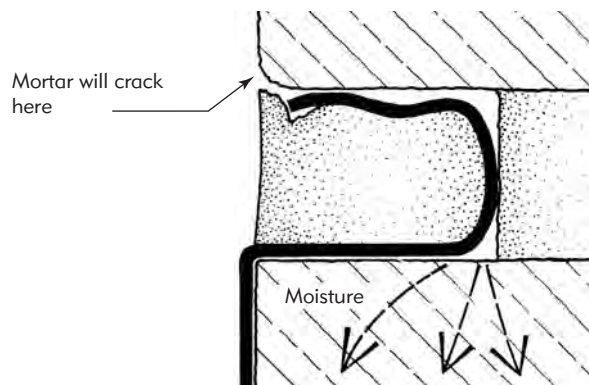


Fig 25.

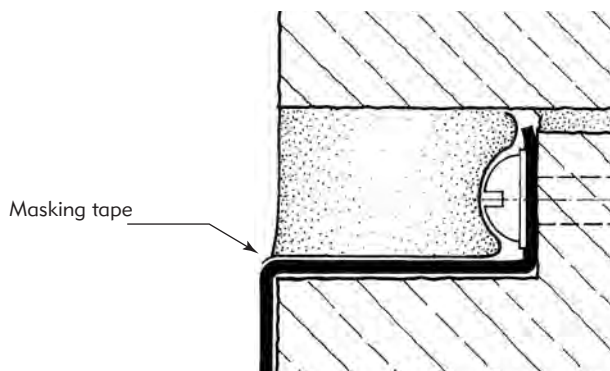


Fig 26.

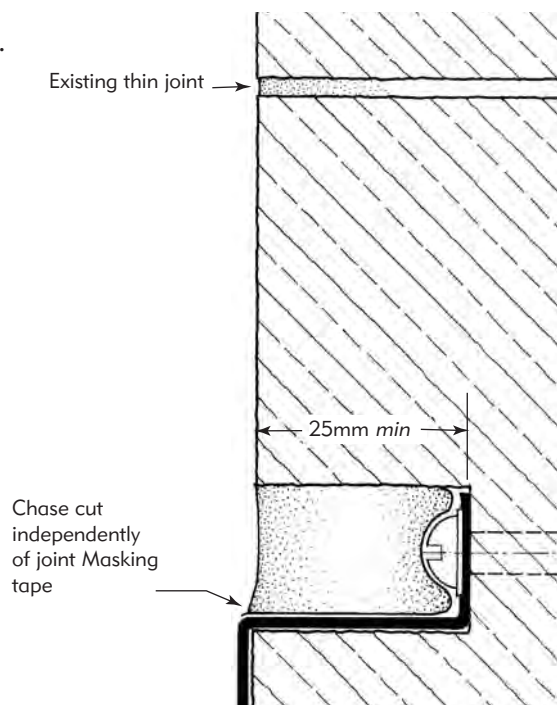


Fig 27.

Alternative to Fig 26

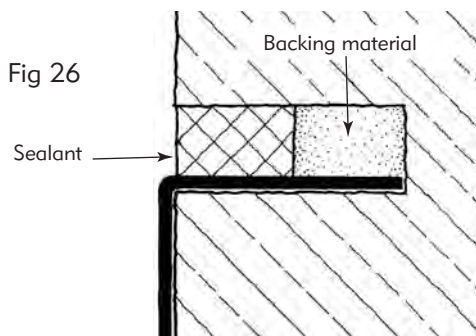
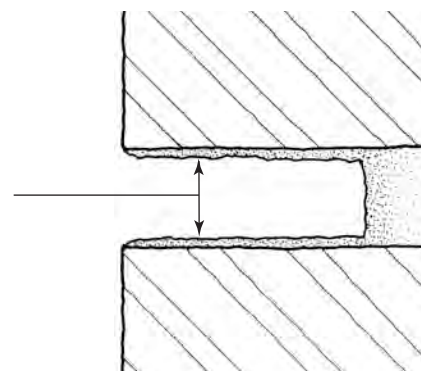


Fig 28.

With existing joints, all this mortar must be removed



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

Water penetration at abutments is often the result of an incorrect or faulty detail where the lead flashing is turned into the same joint as the DPC. Fig 29 shows a detail, often drawn – and theoretically possible – but difficult to achieve in the normal joint width of 8-12mm. For this detail to be effective, the bricklayer must bed the DPC and remove the mortar from under the DPC for a depth of 25mm while it is still soft (green) to enable the flashing to be fitted – usually at a much later date. Subsequent fitting of the flashing into the approximately 4mm-wide joint between the underside of the DPC and the top of the brick is possible but difficult to wedge securely. Pointing with sealant (mortar would be ineffective) is also possible, but again difficult. The detail would therefore be more correct as shown in Fig 30.

To make this detail more practical, the joint width could be increased so that there is not less than 8mm between the underside of the DPC and top of the brick (rarely possible). Alternatively, the bricks could be rebated as shown in Fig 31.

Problems that can occur are shown in Fig 32, where the flashing is turned in directly over the DPC, and Fig 33, where the DPC has been mistakenly removed during the chopping out of mortar.

Another incorrect detail is to fit the flashing one course below the DPC (Fig 34). Although this may prove satisfactory in some sheltered or moderate locations, moisture will be able to penetrate as shown, especially in more exposed situations.

Fig 29.

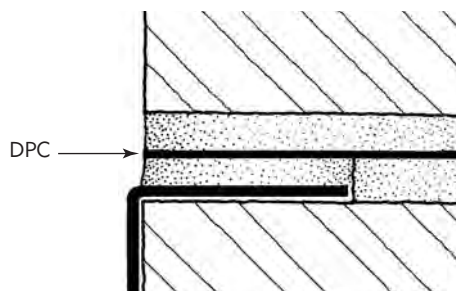


Fig 30.

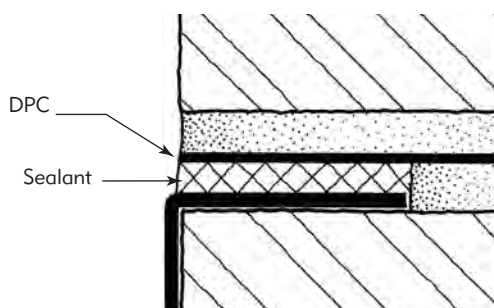


Fig 31.

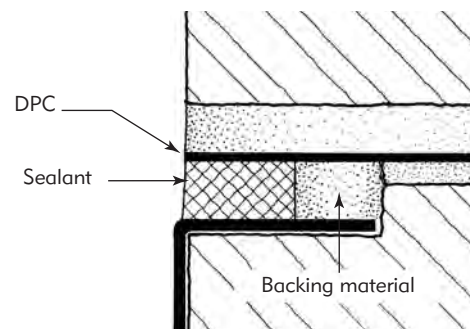


Fig 32.

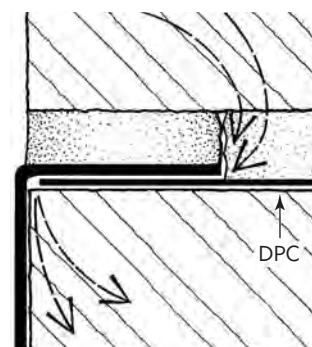


Fig 33.

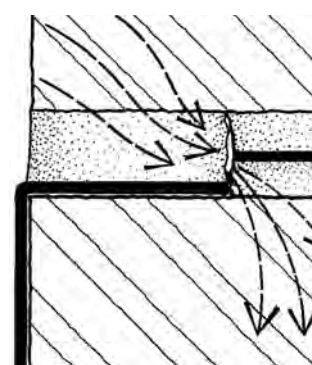
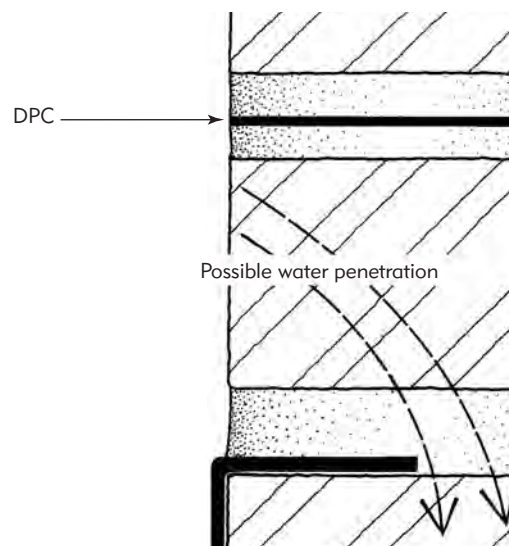


Fig 34.



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-welting, 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.

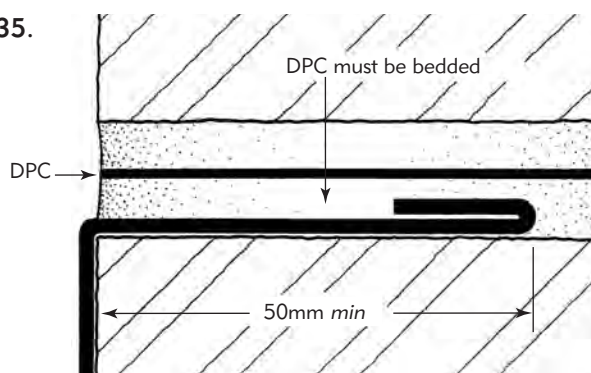
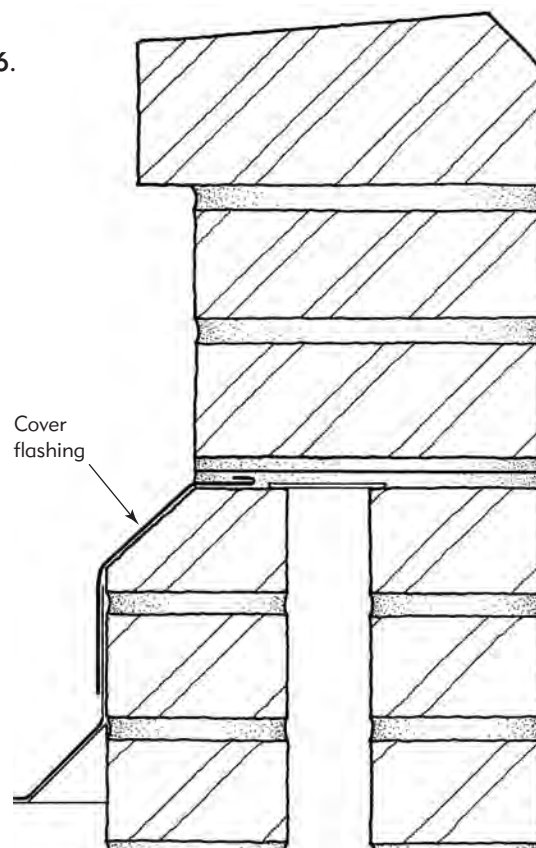


Fig 36.



Fixings to free edges of flashings

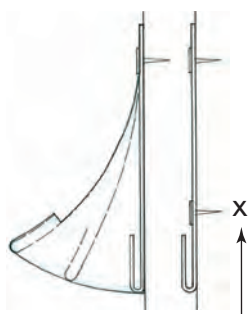
The free edge of a lead flashing must always be adequately clipped to prevent lifting and distortion in high wind conditions. Adequate clipping will depend on the location, orientation and exposure of the building: these will determine the material used for the clips, their spacing and, most importantly,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

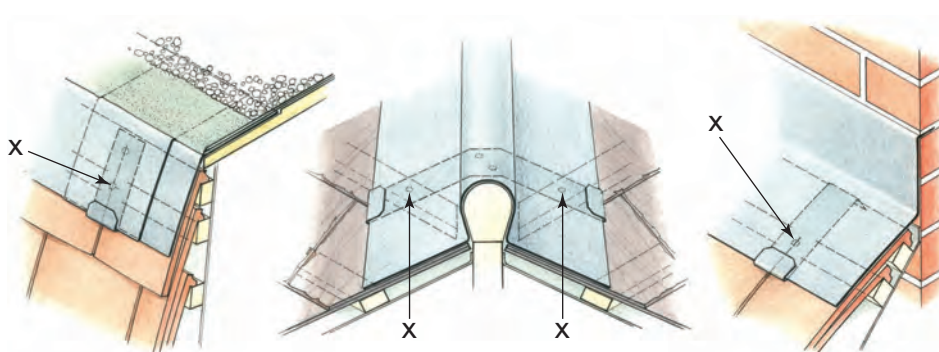
The important principle, 'The lower the fixing, the stronger the clip', is illustrated in Fig 37. Typical examples of extra fixings to clips are shown in Fig 38 – these are vital if clips are to provide effective resistance to wind uplift in storm conditions. For the specification of fixing clips, see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

In conditions of extreme exposure, it may be necessary to fit a continuous clip (Fig 39).

Fig 39. Continuous clips for severe exposure

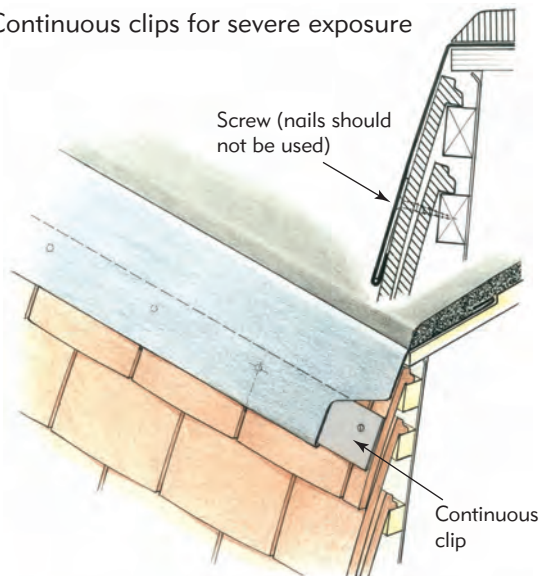
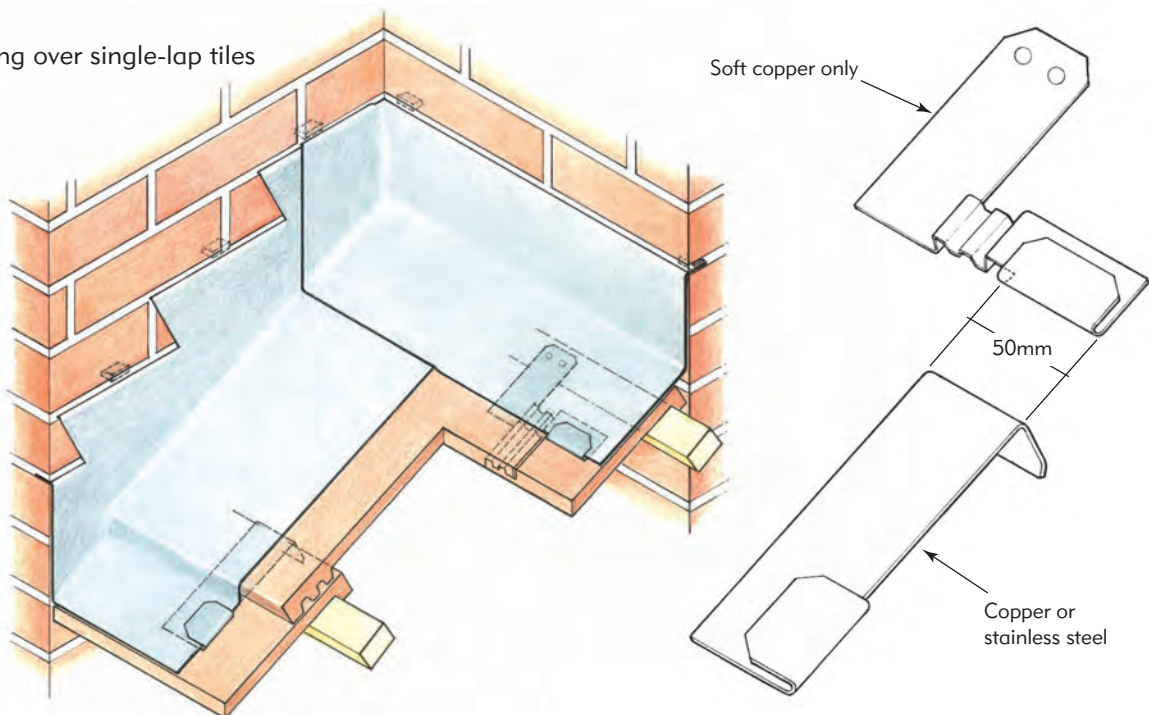


Fig 41 shows methods of clipping the free edges of raking and horizontal abutment flashings over single-lap tiles. For severe exposures, a clip will be needed at every tile joint. In more moderate conditions, one at every second joint – or at every third joint in sheltered locations – would be adequate.

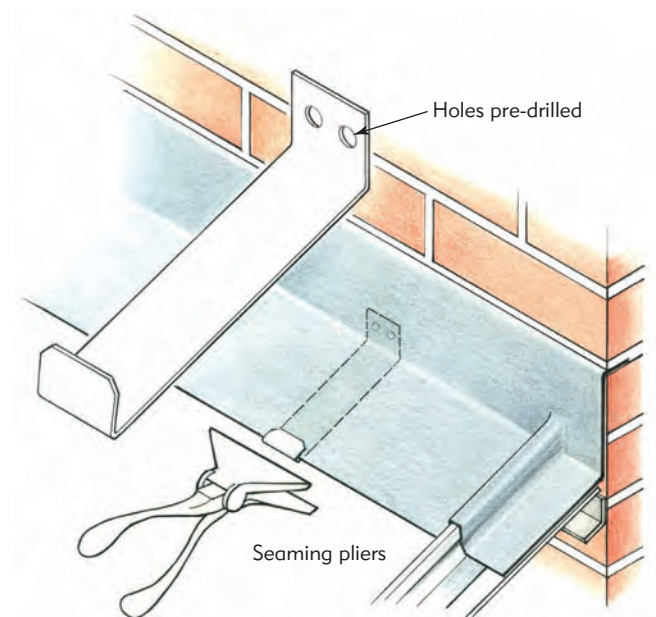
Although both copper and terne-coated stainless-steel sheet are suitable for the clips at raking abutments, it is essential to use only soft copper sheet for the horizontal flashing clips. Malleable 0.6mm copper can be readily shaped to fit the grooves in the side lap of the tiles.

Fig 41. Clipping over single-lap tiles



When flashing over glass, it is not possible to provide a fixing in the lower areas of the clip. Therefore, in moderate and severe exposures, 0.46-0.7mm stainless steel should be used. In very exposed positions, it may be necessary to use 1mm stainless steel for the clips. With these thicker materials, the clip should be pre-bent as shown in Fig 40 and then flattened, using seaming pliers, once the flashings have been fitted. These pliers are also useful for closing all forms of more rigid clipping but their use is especially important when fixing flashings over glass.

Fig 40. Clipping over glass

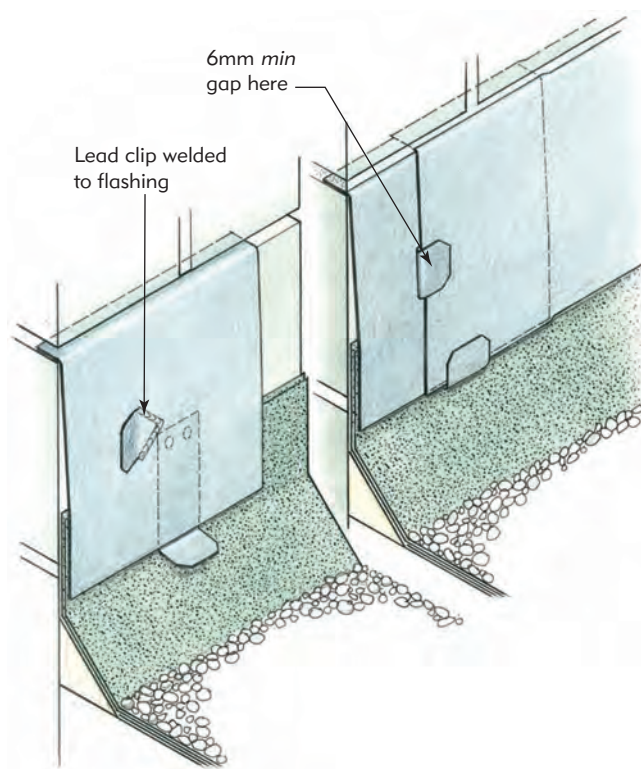


Fixings to free edges of flashings (cont.)

Except for sheltered locations, lead sheet is not usually recommended for clips because of its relatively low mechanical strength when compared with copper and, particularly, stainless steel. However, an example where lead sheet is recommended is shown in Fig 42. The lead-weld should finish close to the line of overlap, with a gap of about 3mm to allow for thermal movement. This type of clip may be required when fixing code 4 or 5 flashings on exposed buildings where the girth exceeds 150mm.



Fig 42. Clipping for wide flashings (150-250mm)



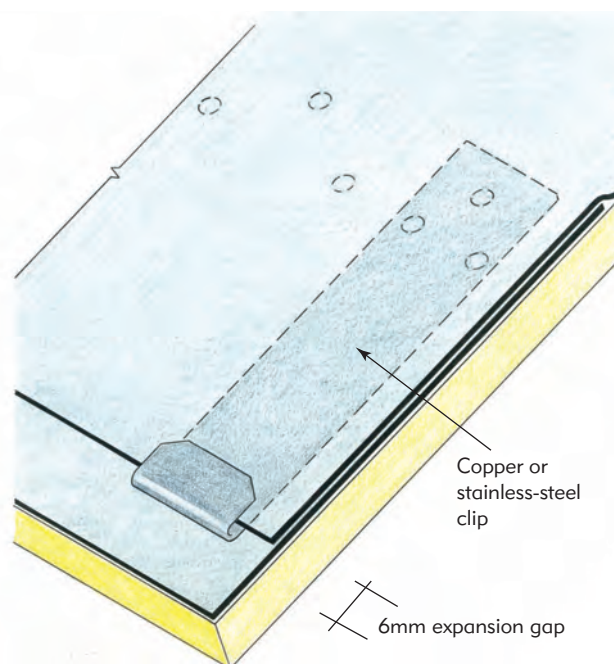
Fixings on free edges of roofing, cladding and weatherings

The free edges of lead sheet roofing, cladding and weathering panels must be adequately clipped to prevent lifting and distortion in high wind conditions. Adequate thickness and method of clipping will depend on the location, orientation and exposure of the building. These factors will also determine the material used for the clips, their spacing and, more importantly, the method of fixing (see 'Clips', page 12).

It is important to remember the principle, 'The lower the fixing, the stronger the clip', as shown in Fig 37, page 26. This is further illustrated in Figs 43-45, where three methods of fixing clips on lap joints are shown. The fixings in Fig 43 are near the top and therefore this clip would only be suitable for very sheltered positions. Although it would be possible to strengthen the clip by nailing lower down, this is not recommended because of the risk of water penetration where the fixings puncture the lead.

The recommended clip where lead is lapped over lead is shown in Fig 44. The weld finishes close to the edge of the overlap, thereby lowering the fixing point (fulcrum) to this position and making this clip suitable for most exposures.

Fig 43. Clip at lap for sheltered exposures



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

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

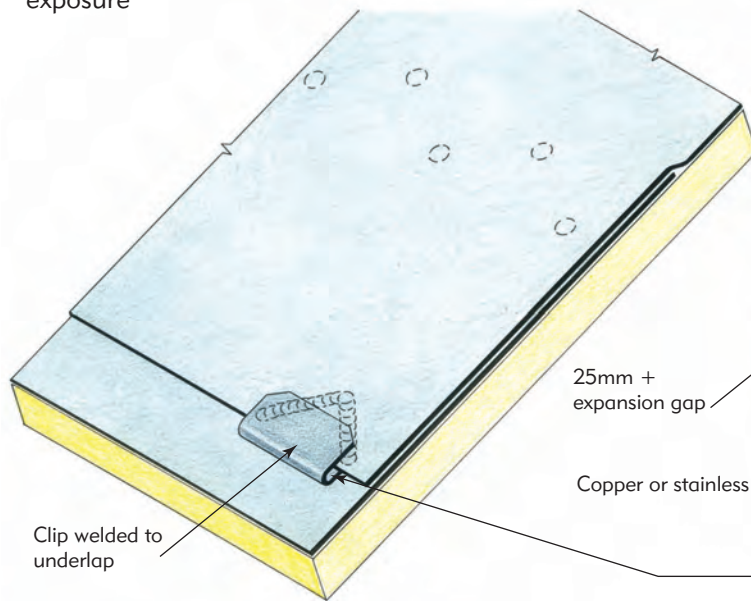
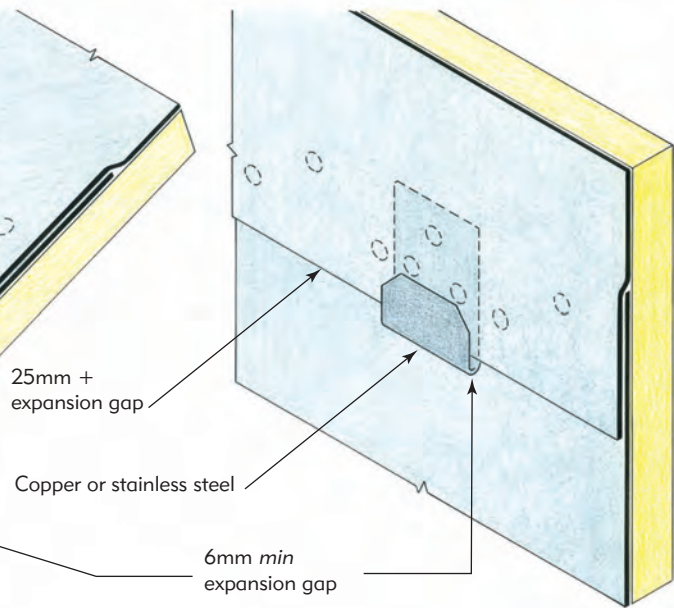


Fig 45. Clip for moderate and severe exposures



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

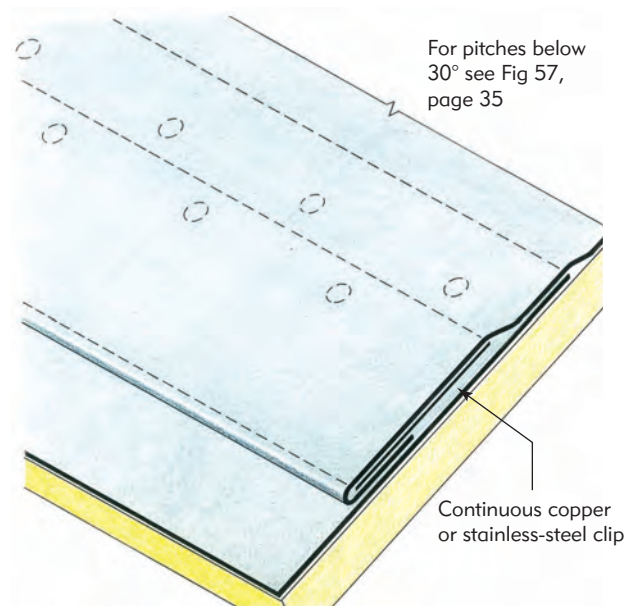
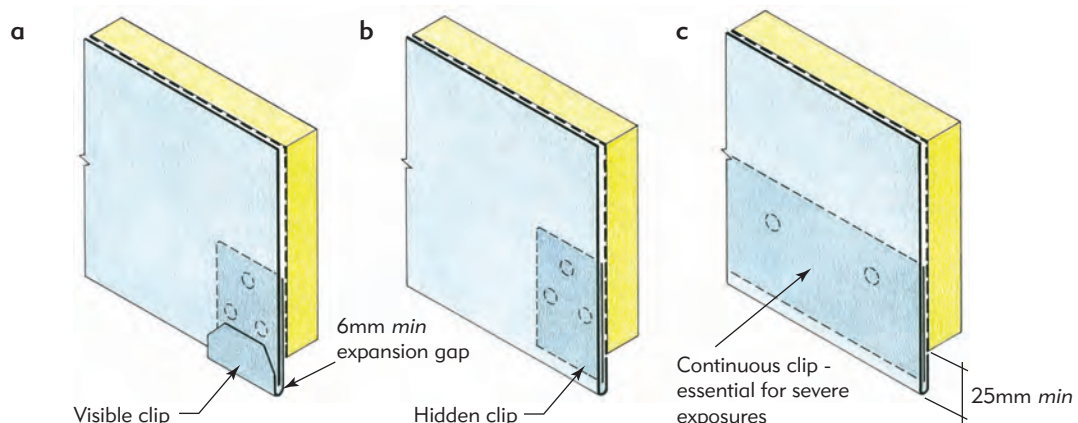


Fig 47. Clips on bottom edge

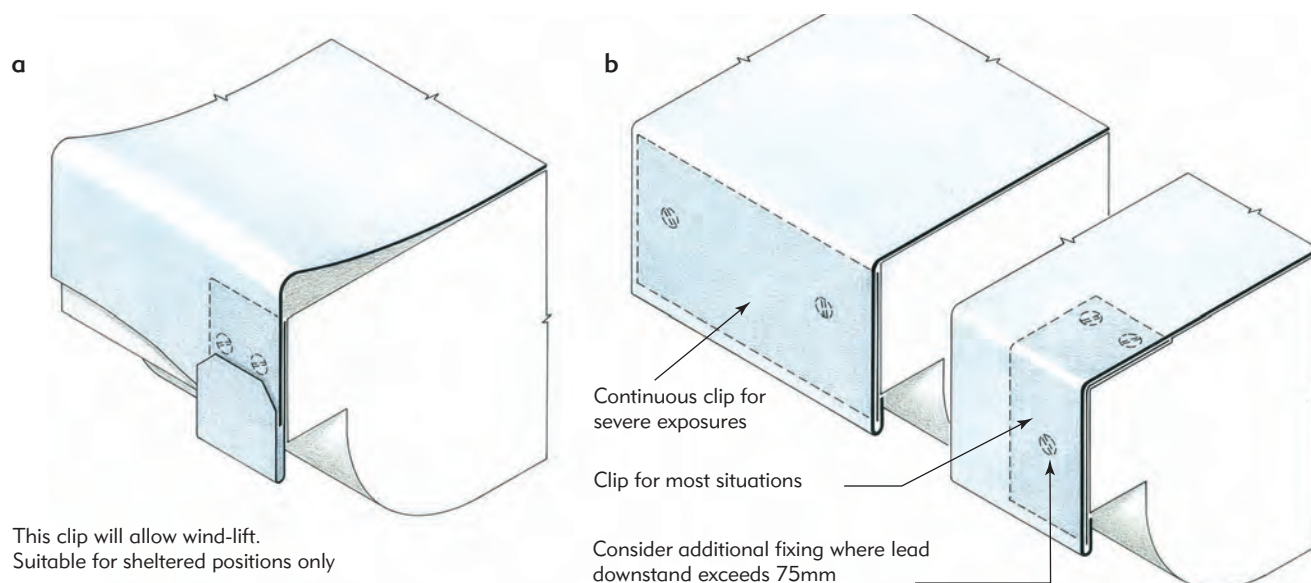


Fixings on free edges of roofing, cladding and weatherings (cont.)

Downturns of verges, eaves and edges of roof coverings, dormer tops, cappings, cornice weatherings etc must be secured with clips. Fig 48 shows two examples. It should be noted that external clips (Fig 48a) have little resistance against wind uplift and therefore should be used only in low-exposure positions.

For most conditions, concealed clips are used (Fig 48b). These can be strengthened considerably by positioning a fixing in the vertical section of the clip, as shown. In extreme exposures, it may be necessary to use a continuous clip screwed to the vertical face of the masonry at about 100mm centres. Spacing of individual clips to free edges, other than roll or drip overcloaks, should be between 300mm and 500mm centres, depending on the degree of exposure to wind uplift.

Fig 48. Clips for cornice weatherings, cappings and roof coverings



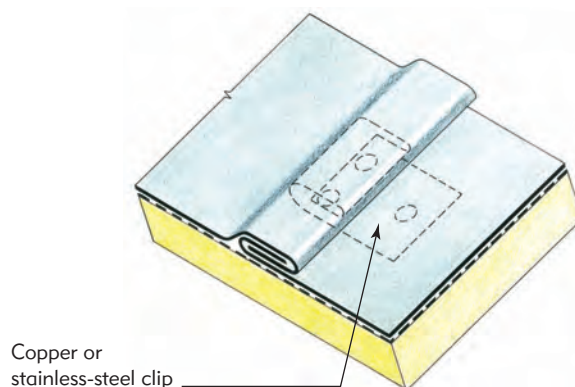
Fixings included in joints

Copper or stainless-steel clips are incorporated into rolls, welts and standing seams to retain the leadwork in position and prevent the bays or panels from lifting under wind pressure or suction. Fig 49 shows a typical 50mm-wide clip in a welt. In the section on joints, Fig 60 shows a clip within a hollow roll, Fig 62a clip in a standing seam and Fig 59a clip in the alternative roll detail.

Spacing of the clips is normally between 300mm and 500mm, depending on the position and exposure of the leadwork. Each clip is fixed to the substrate with three nails or two screws.

When forming the joints, it is important not to dress the clip area too tightly as this can cause the clip position to be seen on the surface of the lead.

Fig 49. Fixings in joints



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.

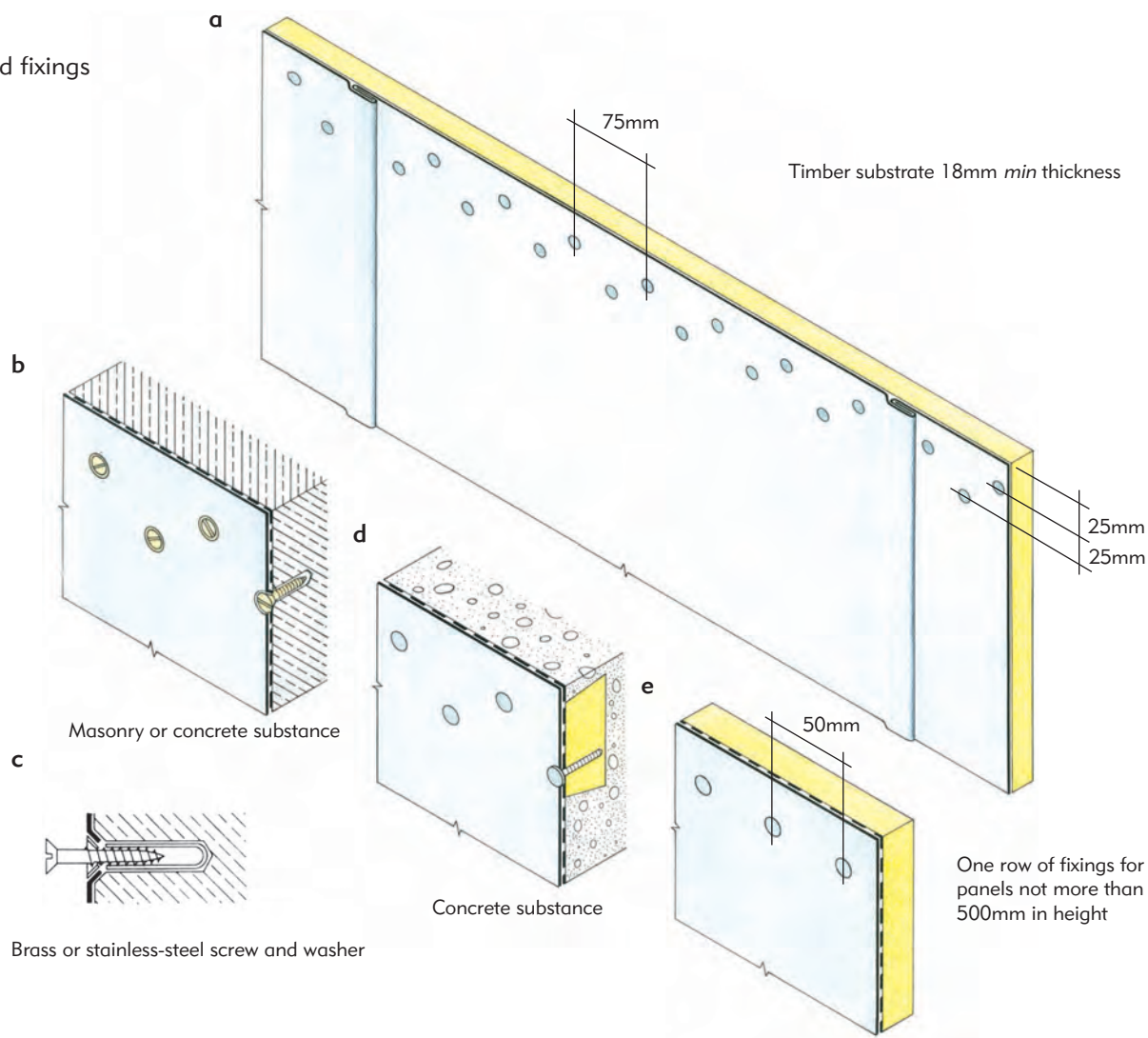
Head fixings to roofing and cladding

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



Intermediate fixings

Although intermediate fixings are occasionally required, they are used much less today than in the past. Experience has shown that securing large pieces of lead with numerous intermediate fixings results in fatigue cracking. Therefore the tendency today is to position the expansion joints (rolls, welts, laps etc) so that intermediate fixings are not necessary.

However, in certain situations, intermediate fixings are required and the important rule when using them is that they must be positioned so that free thermal movement is not impeded. Details of appropriate type and position of fixings are described and illustrated in each section. Intermediate fixings are not a substitute for adequate head fixings and clips to free edges.

Intermediate fixings can be visible or secret. The simplest form of visible fixing is a brass or stainless-steel screw and washer, capped with a small piece of lead sheet (Fig 51a). Where the fixing is positioned in a pitched or vertical surface, the capping piece is suitably shaped for ease of lead-welding in-situ to the lead covering. When using this type of fixing in low-pitch or flat work (such as cappings), it is necessary to weld the capping piece on all sides to avoid water penetration.

Another simple visible fixing is the lead button or dome (Fig 51b). A brass or stainless-steel screw is used with a serrated-edge brass cup washer, onto which the lead dome is secured using a special tool that cramps the dome onto the brass washer.

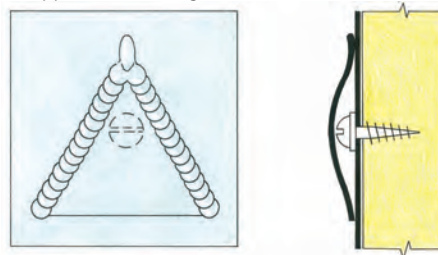
Fig 51c shows the traditional wiped, soldered dot where the lead is dressed into a circular dish cut into the substrate. A brass screw and washer are fixed through the lead and the dish is then filled with solder and wiped flush with the lead surface. This leaves a circular visible fixing usually between 50mm and 75mm in diameter.

The lead-welded dot is formed similarly to the wiped, soldered dot, except that the dishing is slighter and the infill is lead, applied by lead-welding and cleaned off flush with the surface.

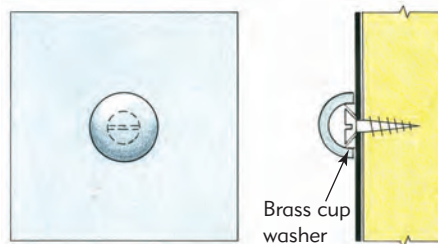
Fig 52 shows a secret fixing, normally referred to as a lead tack, which can be used where there is access to the back of the substrate or when making preformed lead-faced panels for cladding. For the lead tack, a piece of lead 100mm wide and about 200mm long is welded to the back of the panel and the substrate is recessed to allow for the extra thickness of lead. The tack is passed through a slot formed in the backing material and then turned down on the inside and secured with brass screws and washers.

Fig 51. Intermediate fixings

a. Capped screw fixing



b. Lead button



c. Soldered dot

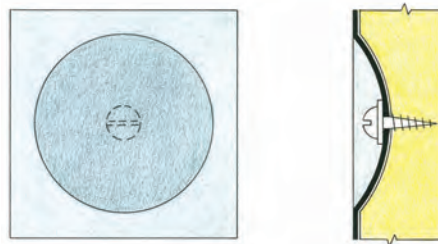
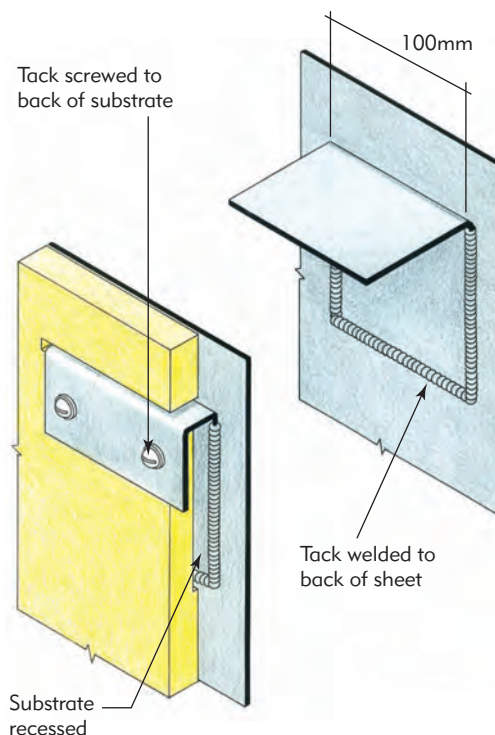


Fig 52. Secret lead tack



Intermediate fixings (cont.)

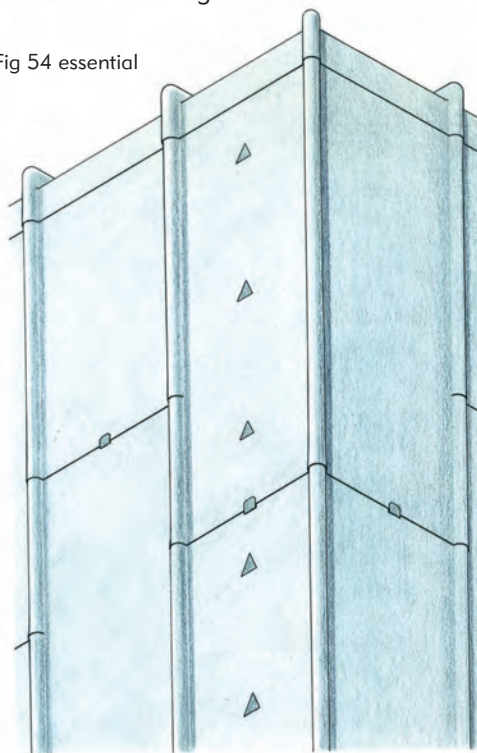
None of the intermediate fixings described on page 32 allow the lead to move when subject to changes in temperature, and therefore they must be positioned so that the restriction caused by their use does not result in distortion of the leadwork. However, in some cases it is necessary to use, or perhaps introduce, intermediate fixings that do allow for thermal movement.

Fig 53 shows an example where intermediate fixings may be required, or introduced after an area of leadwork has been completed for some time, to prevent wind suction adjacent to a corner. Without an allowance for movement, the approach shown would cause the lead to ridge up between the fixings. To make an allowance for thermal movement between these fixings, Fig 51a is modified (Fig 54 detail).

A hole is cut in the lead panel, usually 10-15mm in diameter, and a large brass or stainless-steel washer is used to cover this hole by at least 10mm all round. The washer would therefore be not less than 35mm in diameter. A heavy gauge screw is inserted and tightened so that the washer is just free to move, thereby permitting movement on each side of the screw without restriction. A suitably sized triangular lead cap is then welded over the fixing.

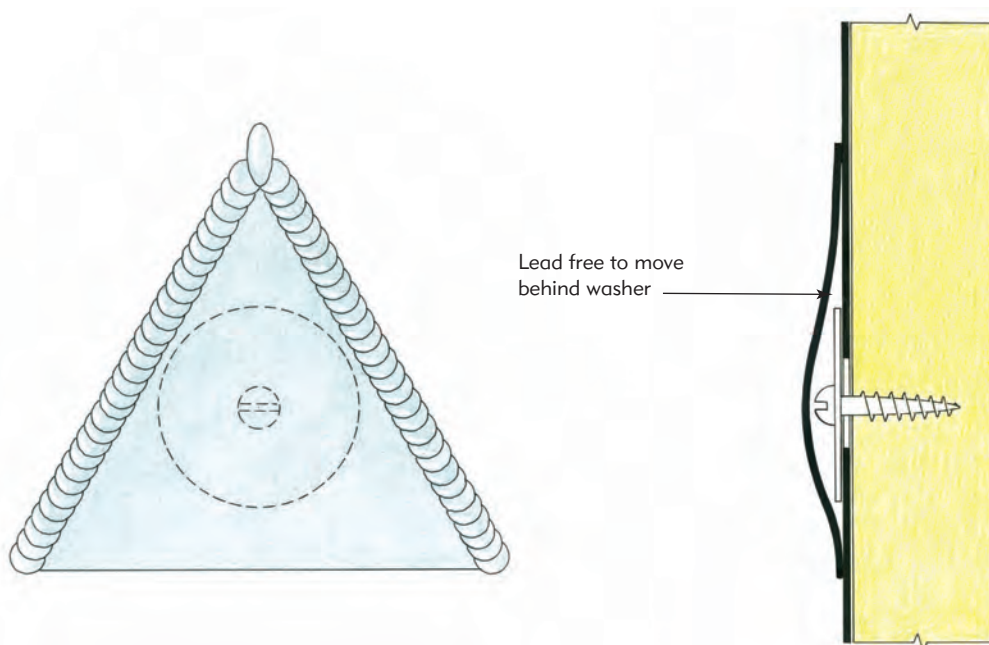
Fig 53. Intermediate fixings

Detail on Fig 54 essential



When positioning the screw and washer over the hole, consideration should be given to the temperature of the lead. For example, in full sunlight on a hot day, the lead sheet will be fully expanded and the screw would be positioned towards the top of the hole. In normal temperatures, the screw would be fixed in the centre of the hole.

Fig 54. Intermediate fixings with allowance for thermal movement



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

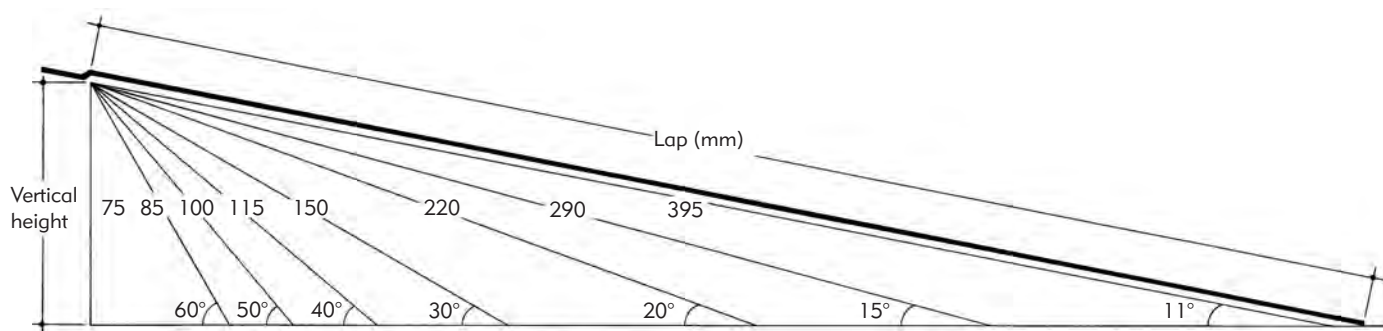
Joints between flashing pieces are usually laps. With abutment flashings, the side laps should be not less than 100mm, increasing to 150mm for locations that are exposed to high wind and rain. Flashings over 200mm in girth will require a side lap of at least 200mm, with the lap clipped as in Fig 42 (page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

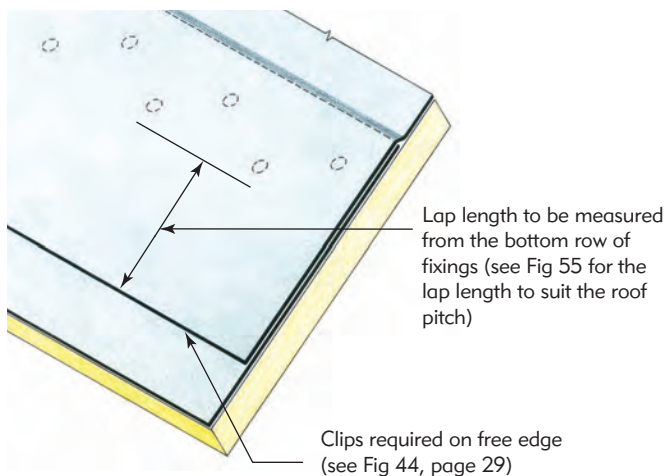
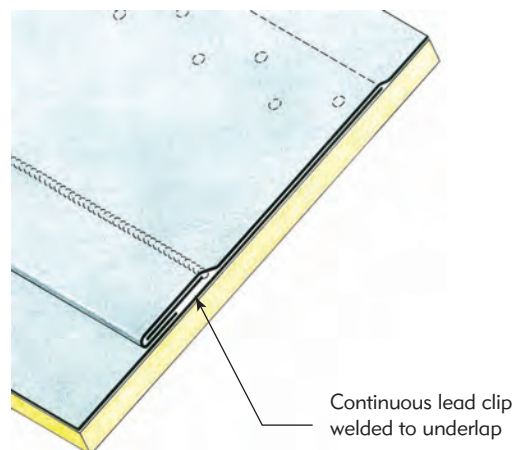


Fig 57. Lap with continuous lead-welded clip



Rolls

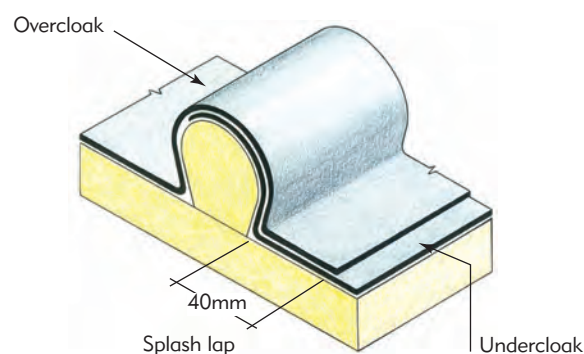
Wood-cored roll

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 welded around copper clips fixed behind the undercloak at 450mm centres.

Owing to the difficulty in achieving a straight line along the welded 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.

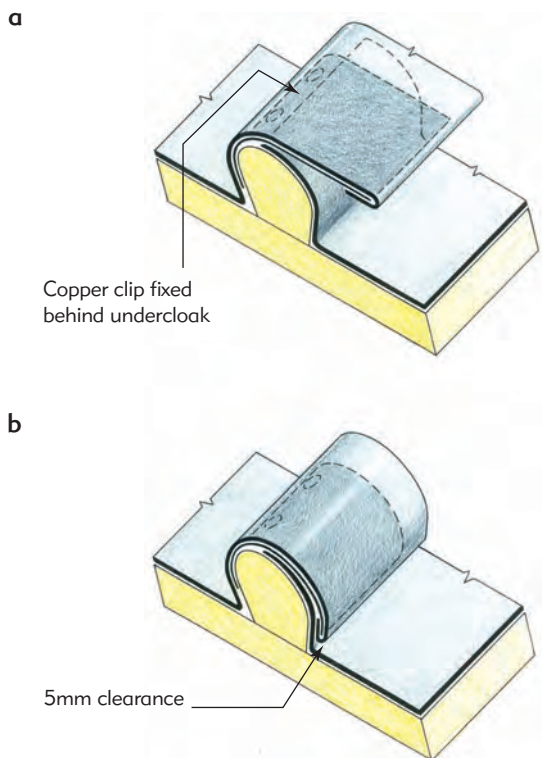


Rolls (cont.)

Wood-cored roll (alternative)

When using the alternative roll detail, the undercloak should finish at the top of the roll so that the copper nails do not penetrate it and cause a restriction on thermal movement. For this detail, an allowance of 65mm is made for the undercloak and 145mm for the overcloak. Again, at the roll ends it will be necessary to extend the undercloak to achieve an adequate side lap (Figs 202-203, pages 118-119).

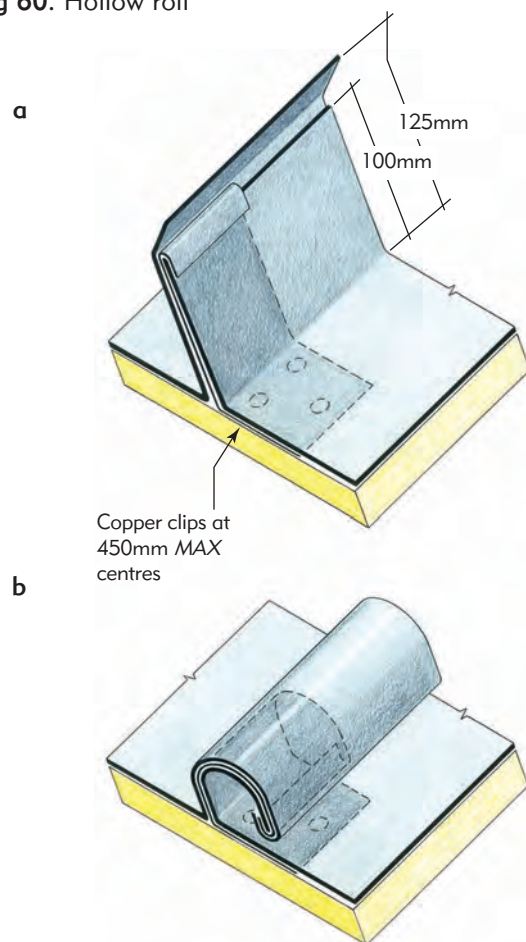
Fig 59. Wood-cored roll alternative



Hollow roll

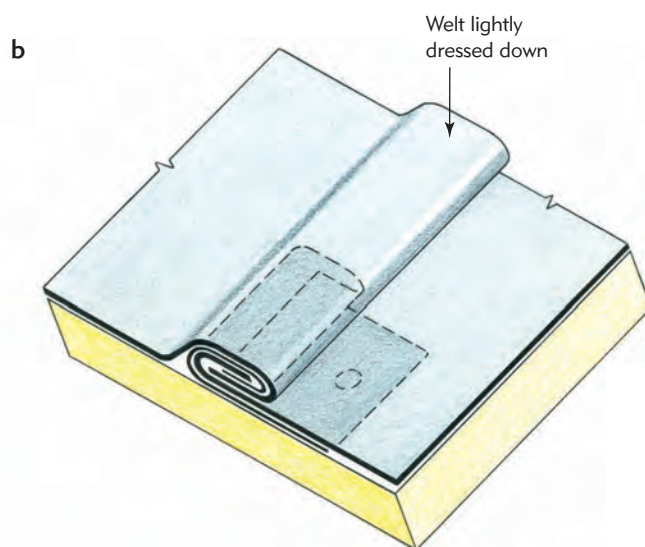
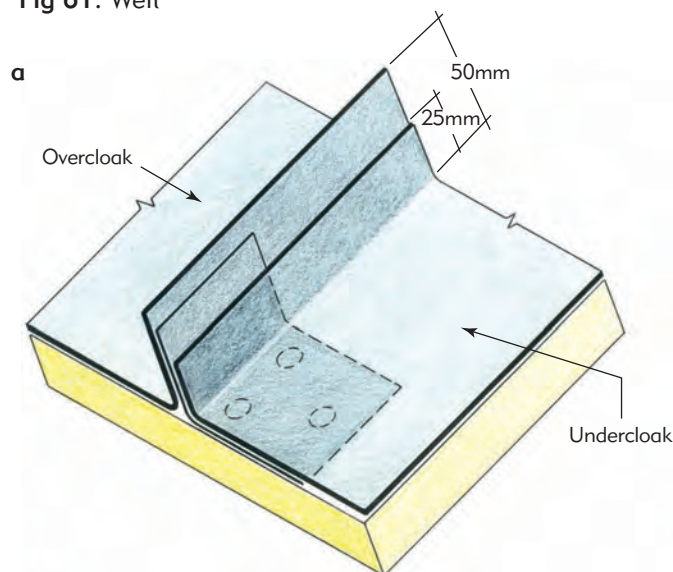
Although this joint can be used for flat and low-pitched roofs, it is more suitable for pitched roof coverings where laps are used for the joints across the fall and where there are few abutments or complicated joint intersections. To form a hollow roll, the undercloak is turned up 100mm, and 50mm-wide copper clips, which have been previously fixed down the line of the roll at 450mm-maximum centres, are turned over the top of the undercloak (Fig 60a). The overcloak is turned up 125mm and the edge welthed over the undercloak. The prepared and clipped upstand is then turned to form the hollow roll (Fig 60b).

Fig 60. Hollow roll



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.



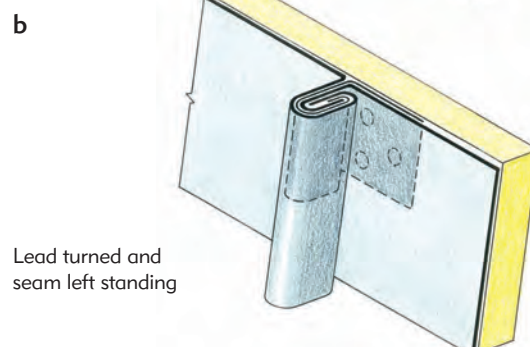
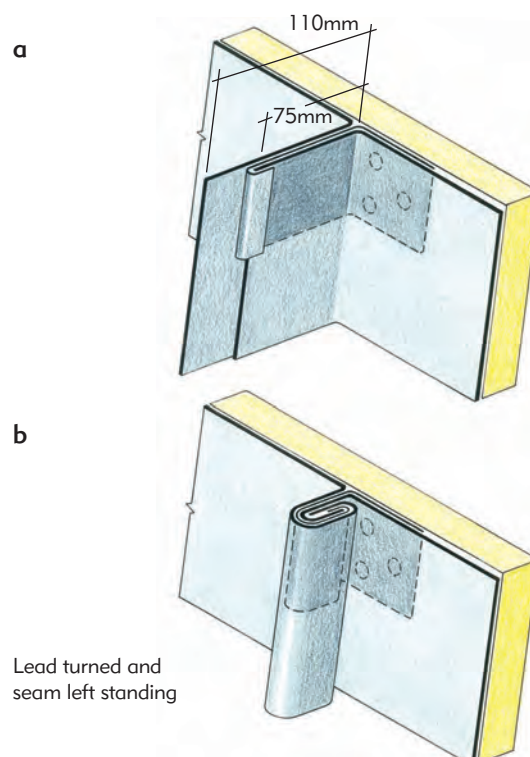
Fig 62. Standing seam

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.



Drips

Fig 63. Drip (up to 3°)

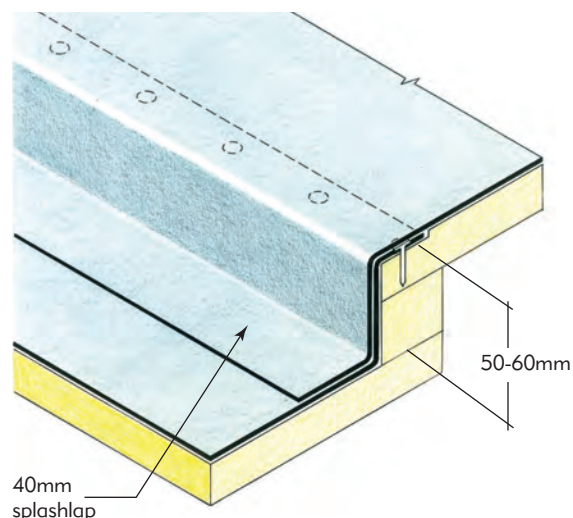
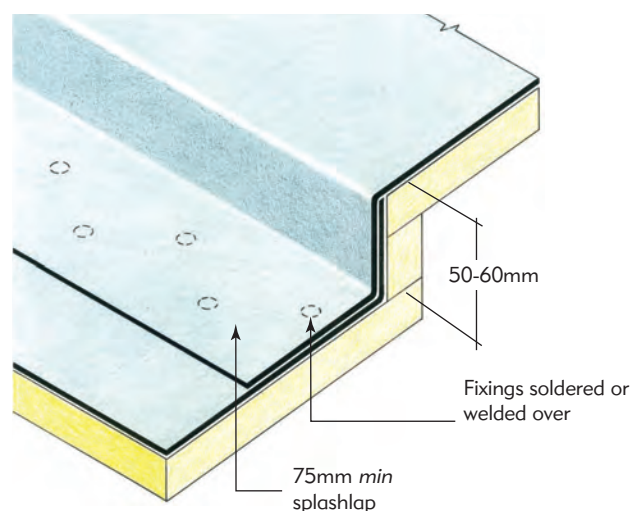


Fig 64. Drip (over 3°)



A drip is used across the fall of flat and low-pitched roofs up to and including 10° in conjunction with the wood-cored roll running with the fall. Drips are also used in lead-lined box, parapet and centre valley gutters. The height of a drip should normally be 50-60mm depending on the thickness of lead sheet used for the roof covering or gutter lining.

In the past, 40mm drips incorporating an anti-capillary groove were sometimes used. Experience has shown that these grooves gradually become ineffective, owing to the collection of atmospheric dirt etc, which makes them vulnerable to water penetration in storm conditions. In addition, 40mm drips are unsuitable for roll-drip abutments. Specific guidance on drip heights is given in Tables 9 and 11 (pages 93 and 124).

For roofs up to and including 3°, the undercloak is rebated into the timber substrate and nailed at 50mm intervals (Fig 63). However, where the pitch is over 3°, the fixings should be positioned as shown in Fig 64 to prevent the roofing bays from slipping downwards. In these cases, it is not necessary to rebate the undercloak, but in order to prevent water penetration through the fixing points, the nails should be sealed over with soldered or lead-welded dabs and the splash lap extended to conceal the fixings.



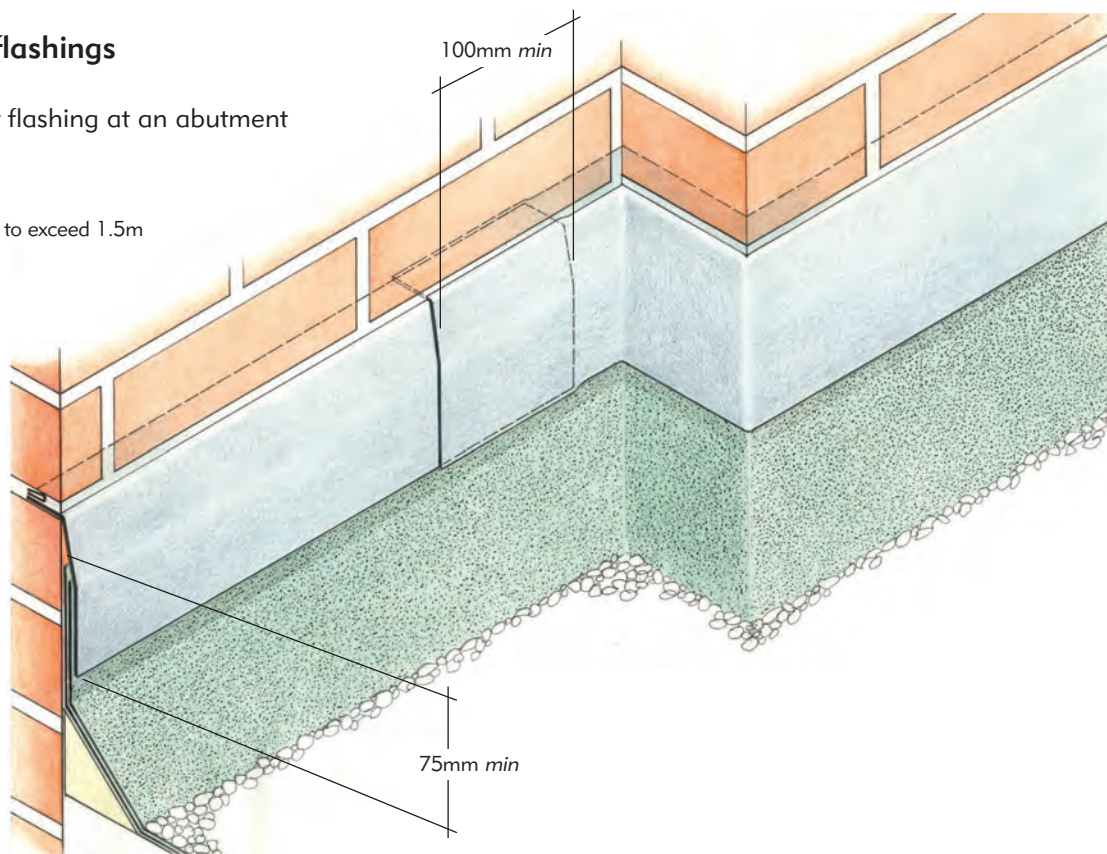
FLASHINGS

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

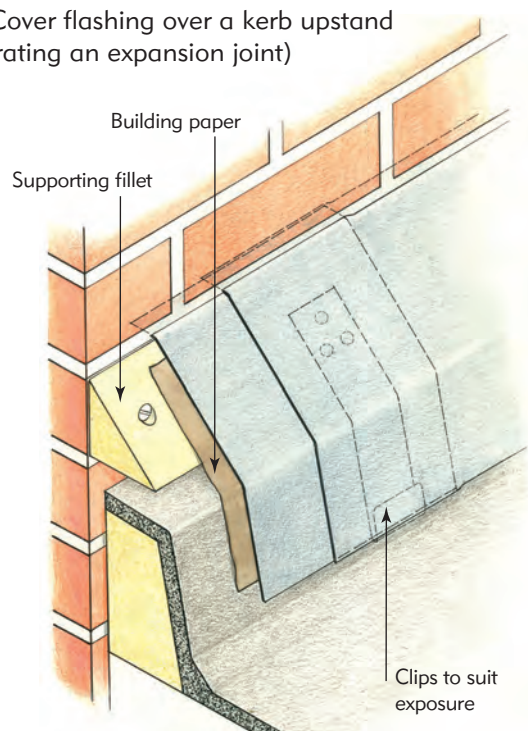
Cover flashings are simply strips of lead sheet with the top edge turned into a wall and wedged at about 450mm centres. The other edge covers over the upstand of the roofing material – bituminous felt or asphalt, for example – by not less than 75mm (Fig 65). End-to-end laps should be not less than 100mm,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

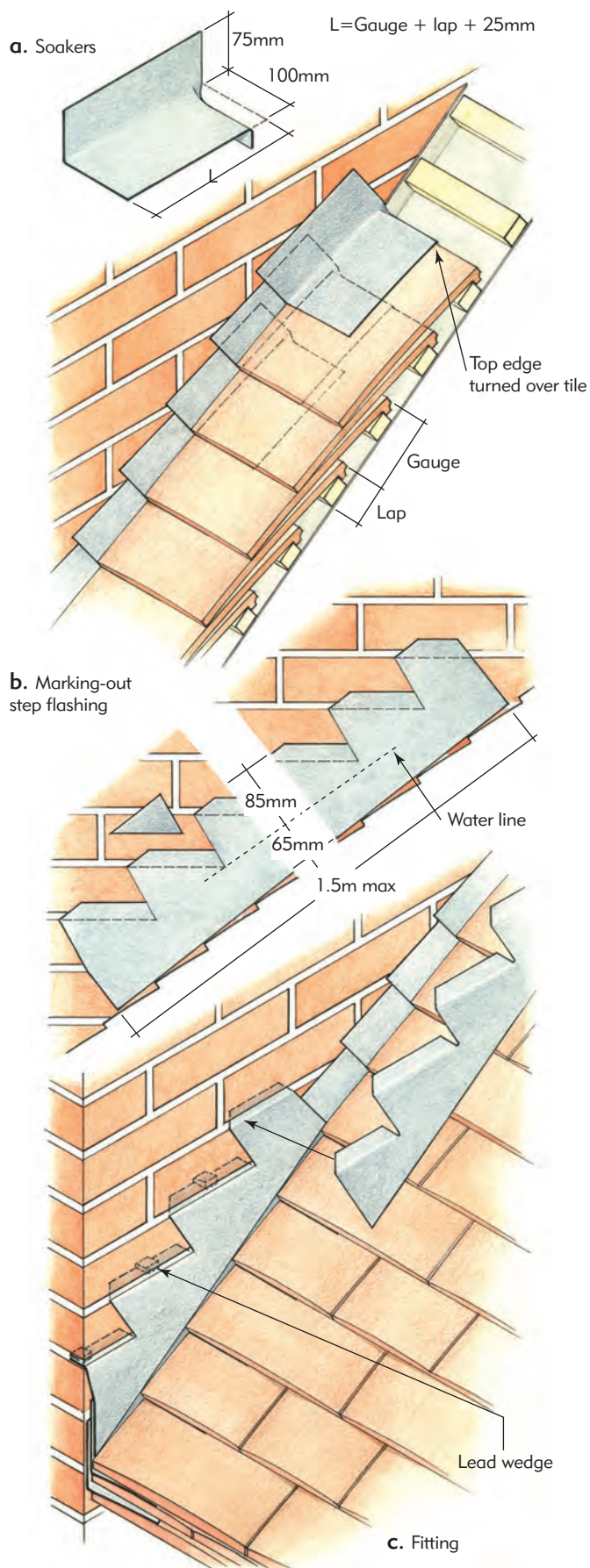
The width of a soaker should be a minimum of 175mm to allow for a 75mm upstand against the wall and 100mm under the tiles or slates. Soakers are usually made from code 3 lead sheet. Fig 67a shows soakers in position.

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

Refer to page 179 fig 285 for soakers on dormers



Abutment flashings (cont.)

Step flashings to single-lap tiles

This flashing is prepared and fixed as described for step flashings over soakers but with an additional minimum allowance of 150mm to cover over the tiles, making an overall girth of not less than 300mm (Fig 68).

When flashing over deeply profiled tiles (or on pitches below 25° in severe exposure situations), it may be necessary to increase the cover over the tiles from 150 to 200mm. The amount of lap between each piece depends on the angle of roof pitch (Fig 55, page 34).

In all cases, the free edges of the lead should be clipped to suit the exposure to wind-lift. code 4 lead sheet is the minimum thickness for step and cover flashings, although code 5 may be preferred when dressing down over deeply profiled tiles.

Single-step abutment flashing

While these individual flashings are particularly suitable for weathering the abutments to stone walls, they are also used on brick abutments in exposed situations.

The advantage of single steps is that the most vulnerable point on a step flashing – where the raking cut meets the turn-in – is eliminated as each step protects this point by lapping the step below (Fig 69).

Single-step flashings are an alternative to 'continuous' step flashings and can be employed over soakers, cover flashings or secret gutter linings. They are particularly practical and economical at very low-pitched abutments. The steps should provide a cover over soakers or upstand of not less than 65mm. It is important to remember, however, that with all abutment flashings the 25mm turn-in will not prevent rainwater that penetrates into the wall from seeping into the area below.

Where single-step flashings are used with a cover flashing (Fig 69), the 1.5m lengths of cover flashing are held in position by turning them over the top of a tile, as shown. On pitches over 30° however, it will be necessary to provide extra fixings in the top third of each piece.

Flashing to stone walls

There are many types of stone wall and in most cases single-step flashings are used to accommodate variations in coursing. An example is shown in Fig 70a.

With ashlar and uncoursed rubble walling, a chase is cut parallel to the roof slope and not less than 100mm above it. It is essential to lap the flashing pieces as shown in Fig 70b.

Fig 68. Step and cover flashing over single-lap tiles

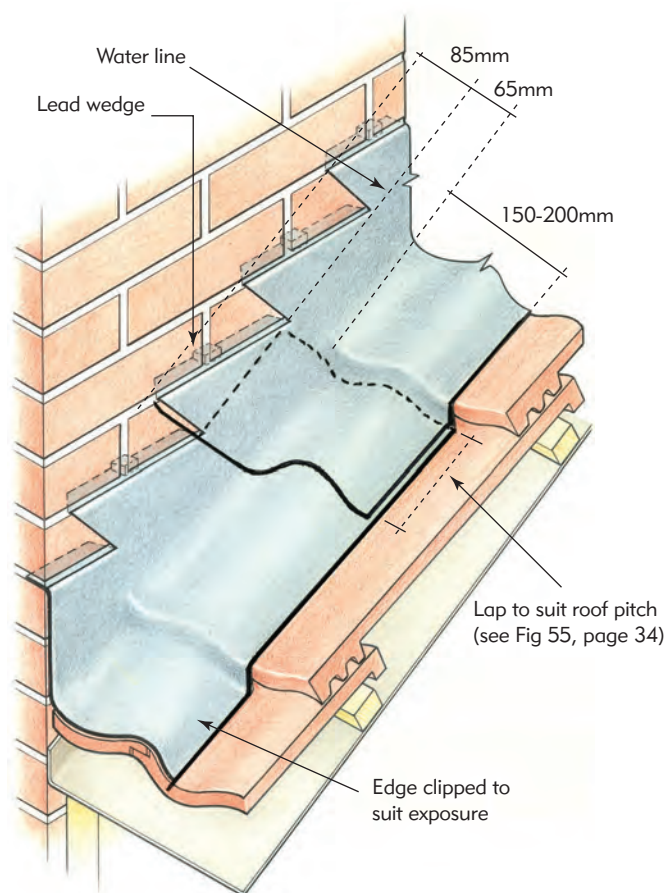
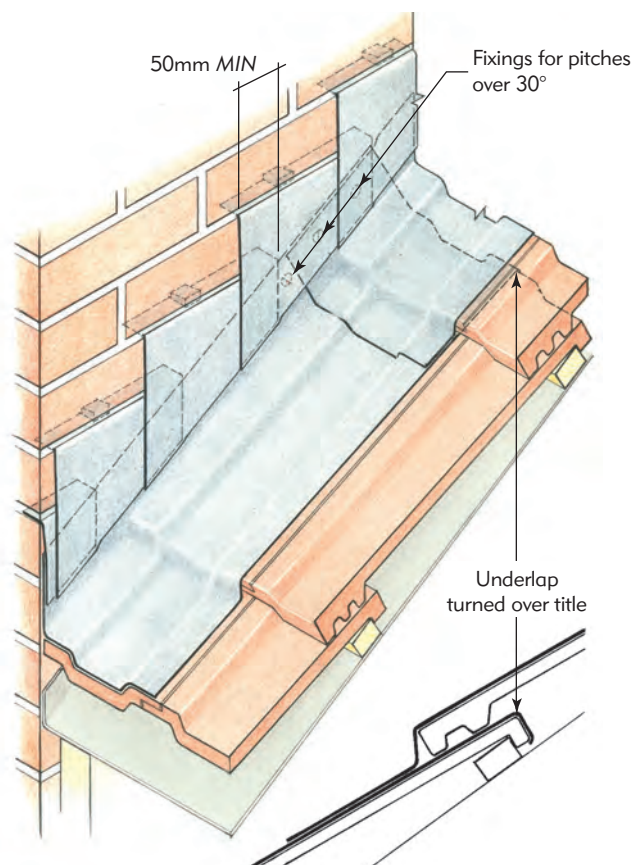
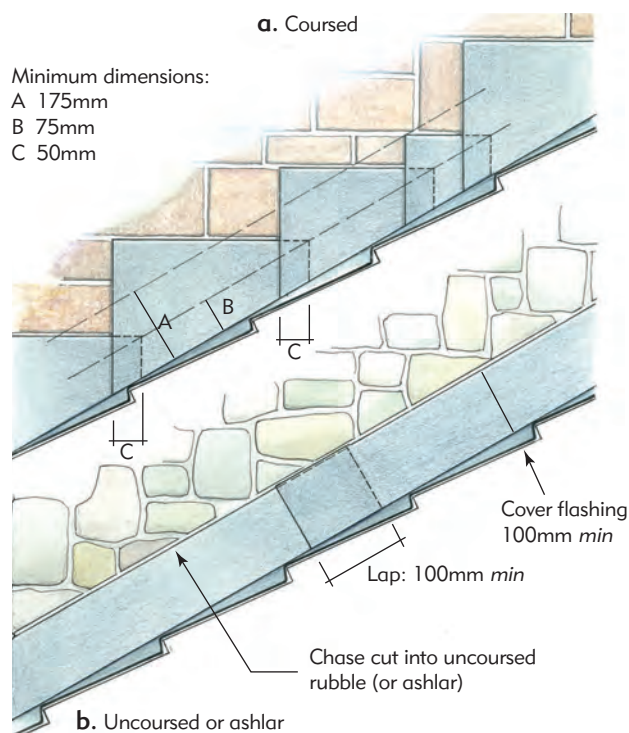


Fig 69. Single step and cover flashing



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

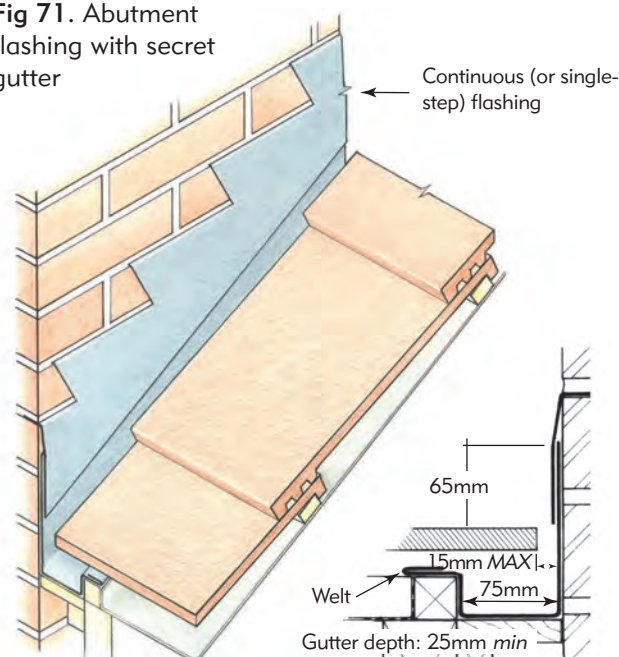


Fig 72. Abutment step and cover flashing with secret gutter

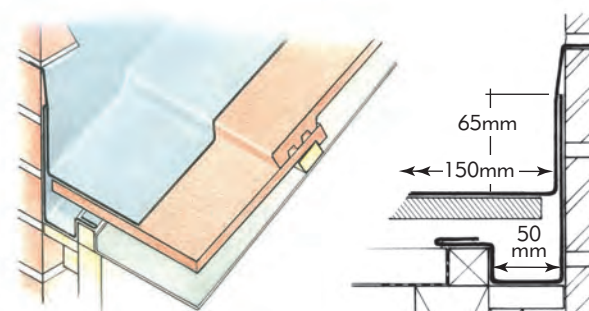
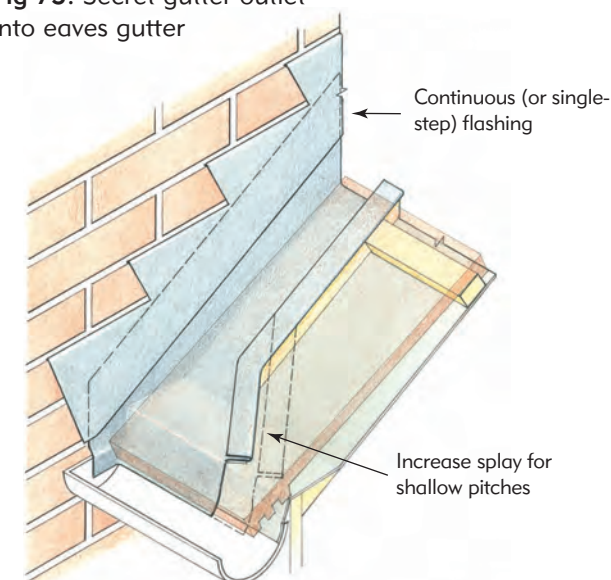


Fig 73. Secret gutter outlet into eaves gutter



Abutment flashings (cont.)

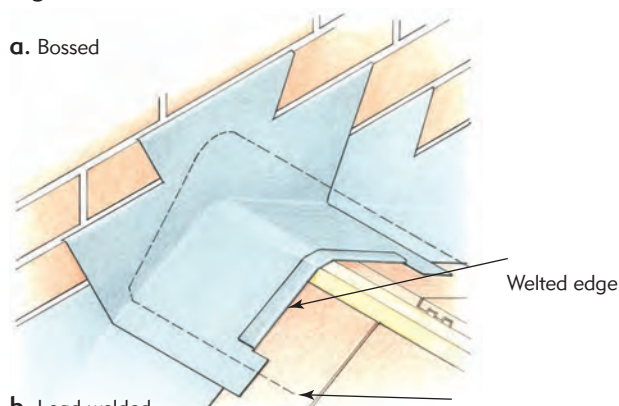
Saddle at abutment

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.

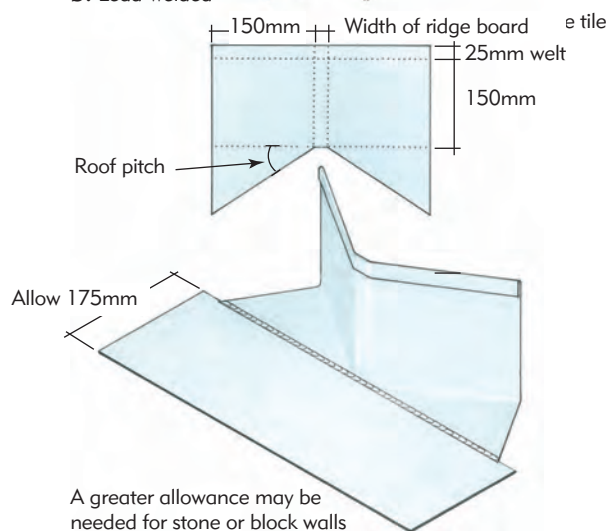
With shallow-pitched roofs, the saddle is usually bossed to shape on the bench, with the steps marked and cut in position as required for fixing to the wall. For steeper roofs, the alternative lead-welded method (Fig 74b) is generally more practical. In both cases, the edge under the ridge tile is welted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

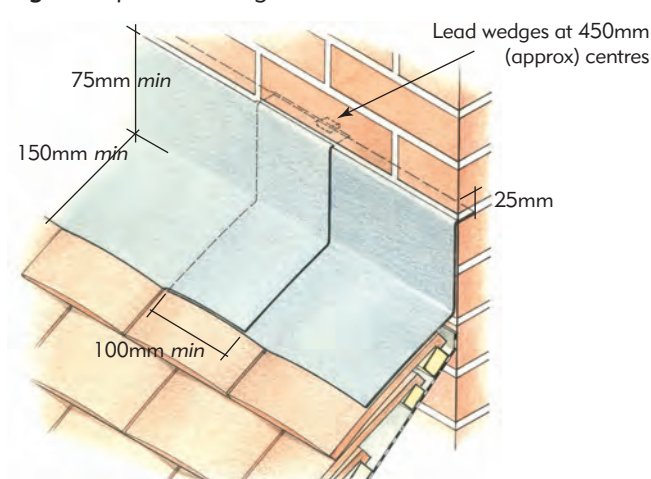


Fig 76. Apron flashing at abutment with sharp-edged interlocking tiles

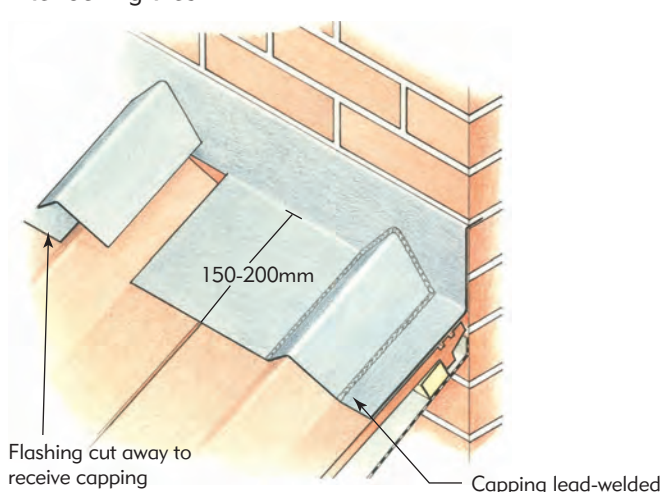
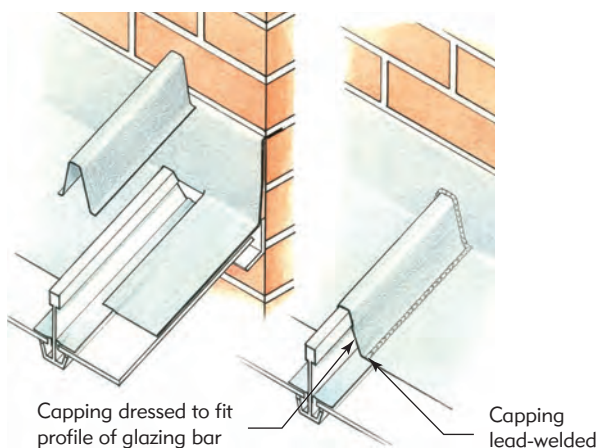


Fig 77. Apron flashing at abutment with high-profile patent glazing



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.

Abutment flashings (cont.)

Fig 78. Internal corner

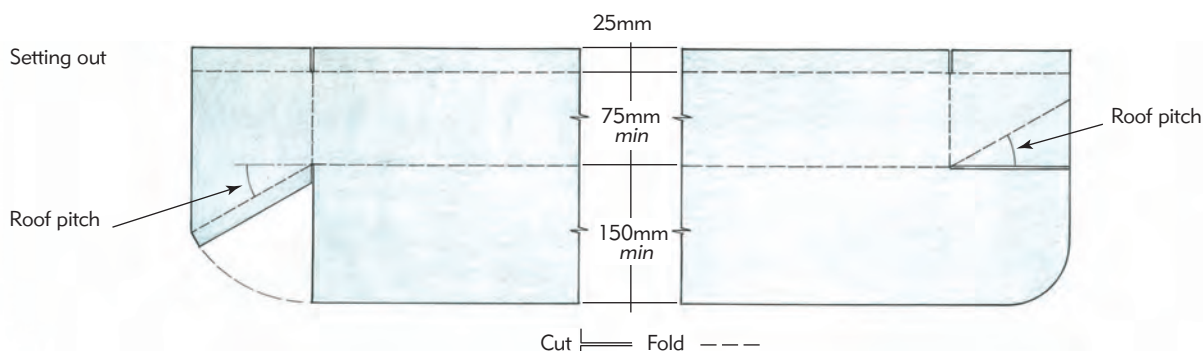
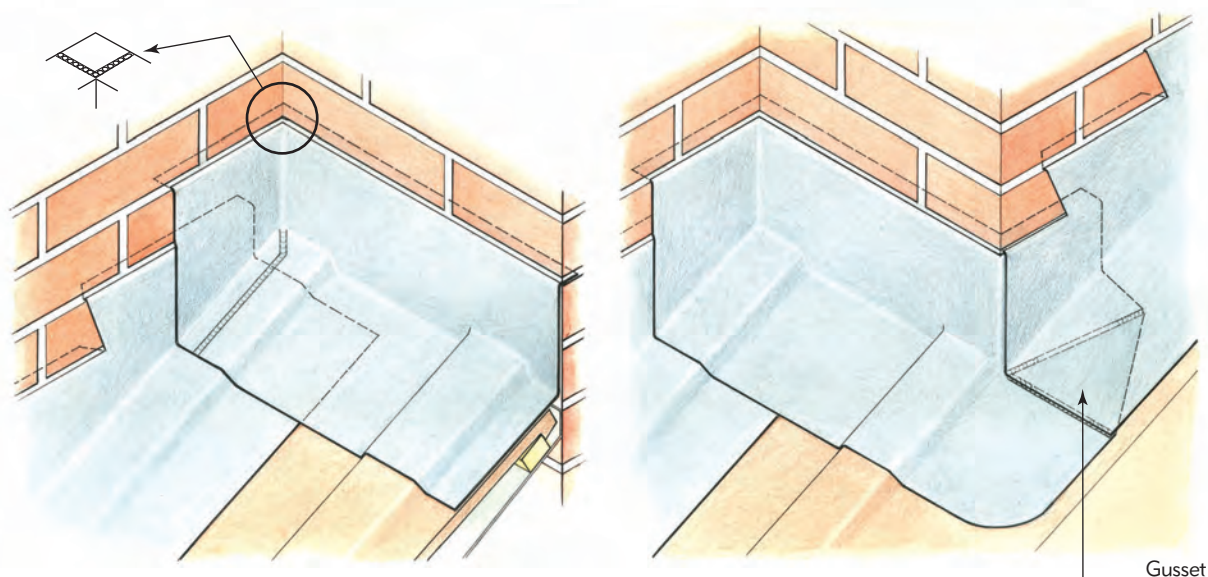


Fig 79. External corner



Internal and external corners

Situations often arise where a chimney or other projection crosses the abutment.

The internal corners (Fig 78) are set out, cut, folded and then lead-welded as shown. It is important to fit a small gusset in the corner of the 25mm turn-in.

External corners are formed as in Fig 79. This is a similar detail to the front apron of a chimney (Figs 80-82).

The detail behind a projection is similar to a chimney back gutter but the internal corner is cut and lead-welded to form a box end (Fig 90, page 47).

Chimney flashings

When a chimney is situated in the roof slope, it will require a front apron, side flashings and a back gutter with cover flashing.

A chimney on the ridge will need two front aprons, side flashings and two saddle pieces. The side flashings should be of the type appropriate to the roof covering, as shown in Figs 67-74 (pages 40-42).

The order in which each part is fitted depends on the preference of the installer but, generally, the back gutter is made and fitted before the roof is tiled or slated, while the front apron, side and cover flashings or saddles are added later.

However, it is possible to completely weather a chimney before tiling, and here the back gutter would be fitted after the front apron and side flashings. This avoids the risk of damage to the roof surface that may arise if the chimney is weathered after tiling (for example, where lightweight tiles have been specified). In these situations, the flashings are fitted to allow a distance between the underside of the lead and the top of the rafters (or trusses) equal to the combined depth of the tiles/slates and battens. The flashings are then dressed down onto the tiles or slates as they are laid.

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

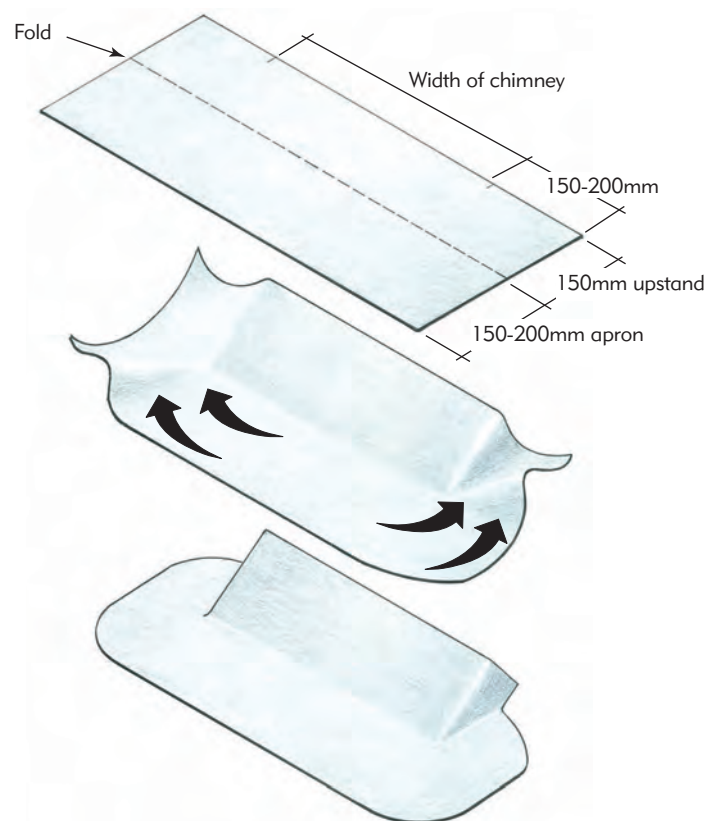


Fig 81. Front apron - lead-welded

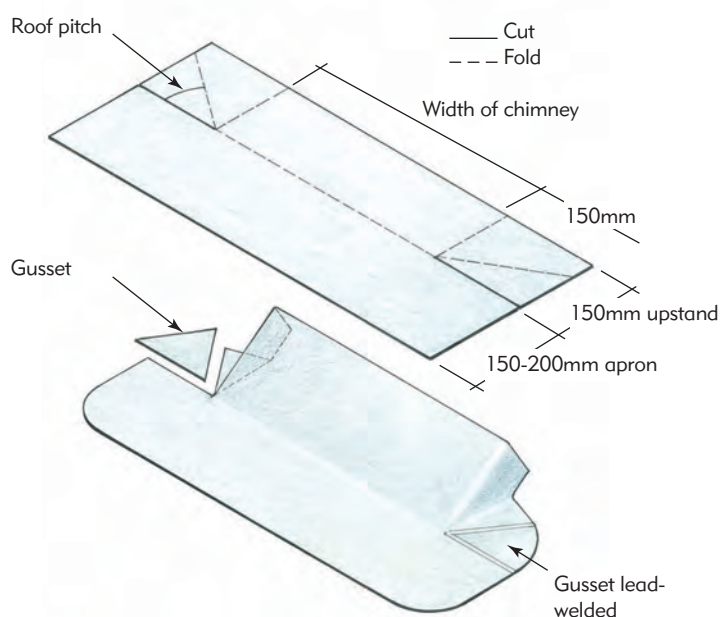
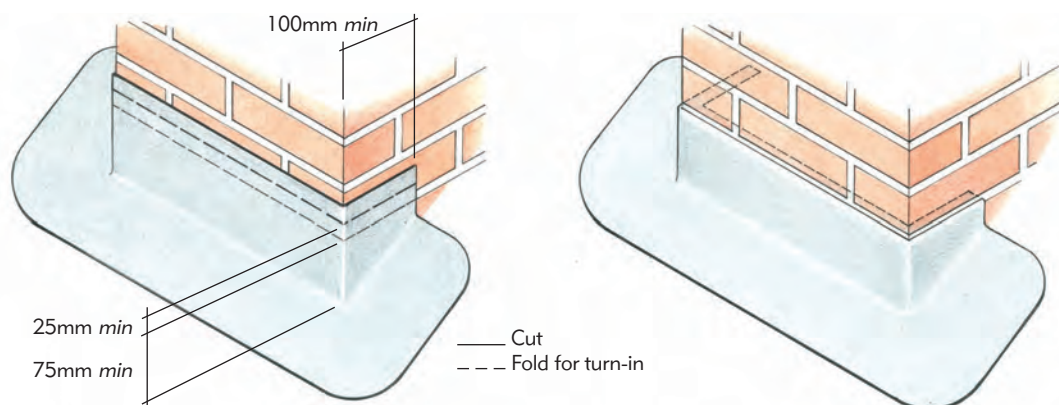


Fig 82. Front apron in position



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

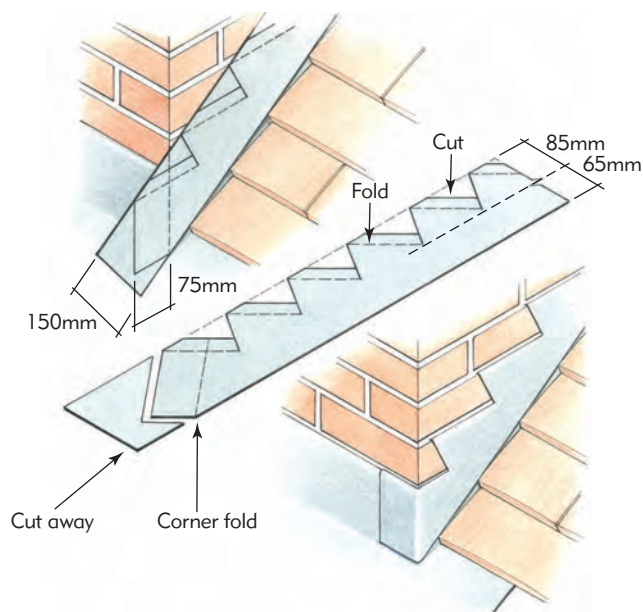


Fig 84. Side flashing – bossed

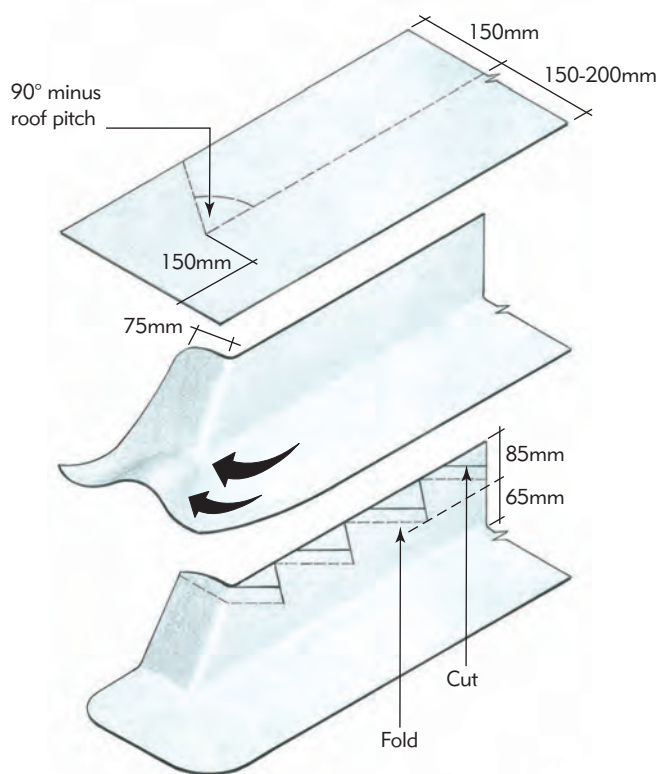


Fig 85. Side flashing – lead-welded

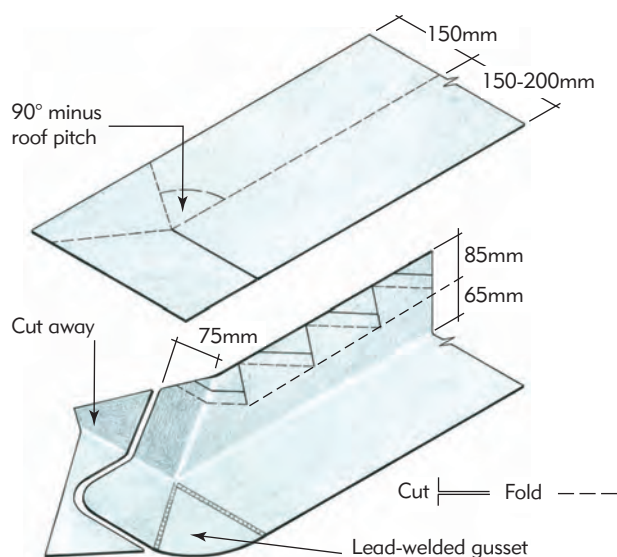
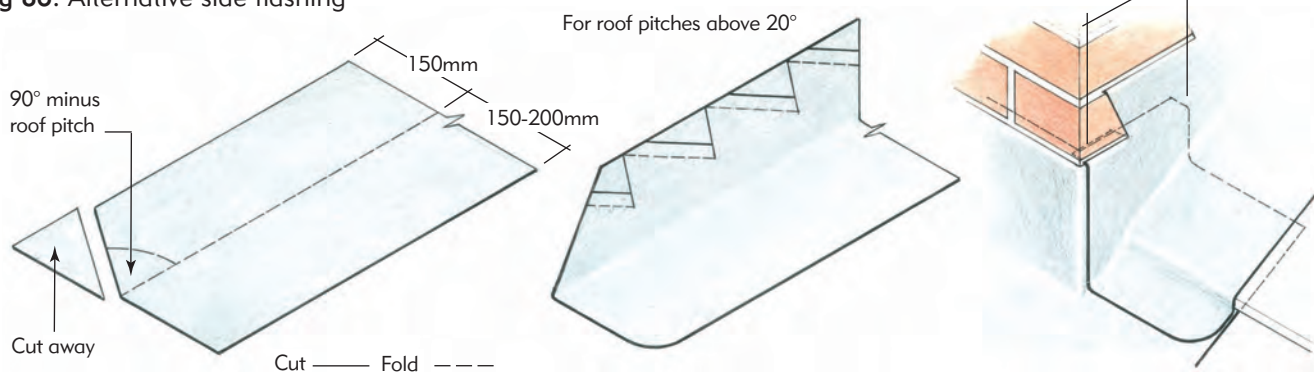


Fig 86. Alternative side flashing



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

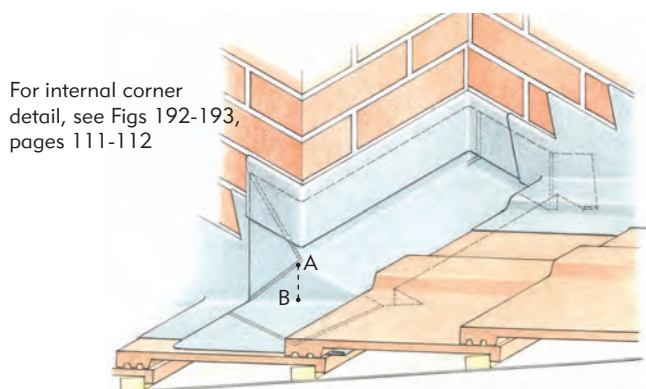


Fig 87. Back gutter - bossed

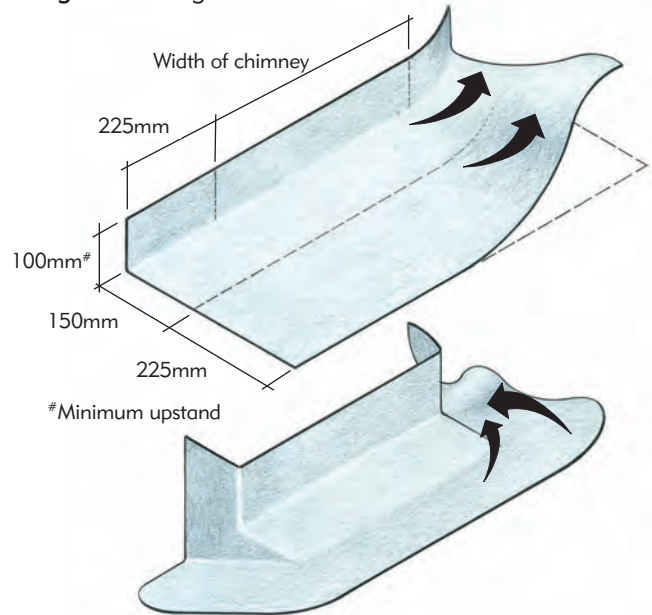


Fig 88. Back gutter - lead-welded

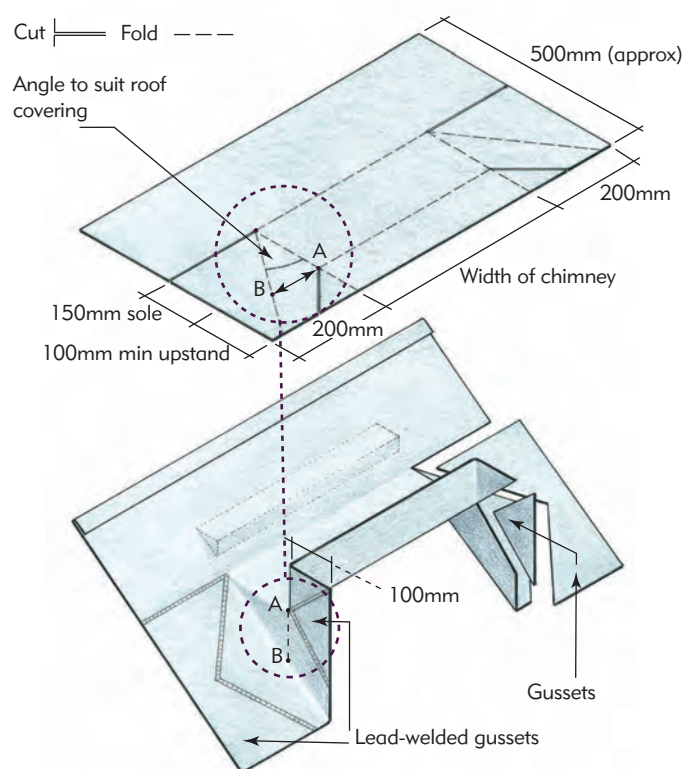
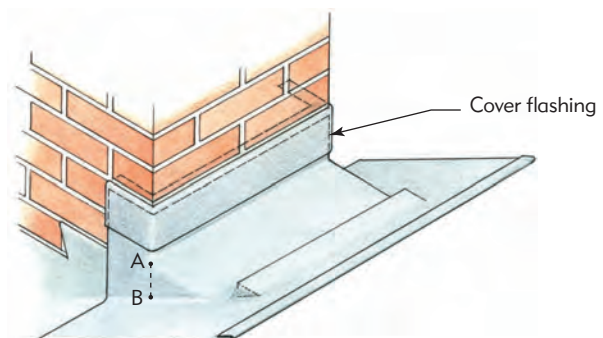


Fig 89. Back gutter in position



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

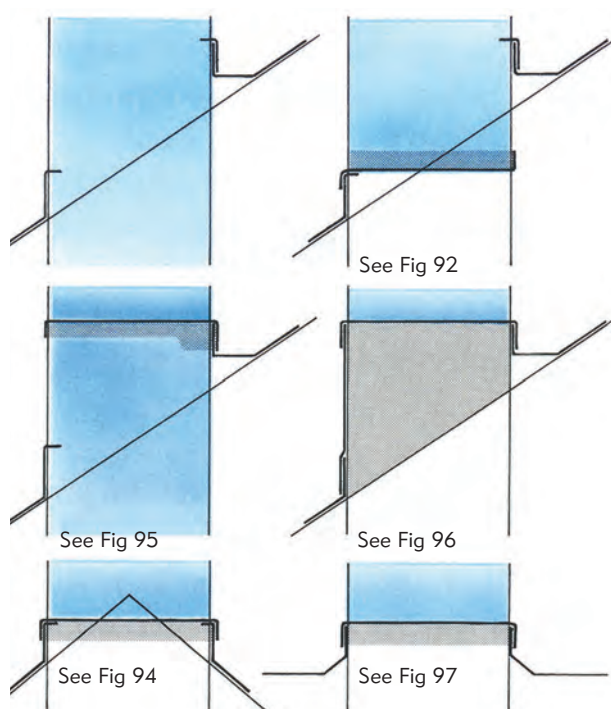
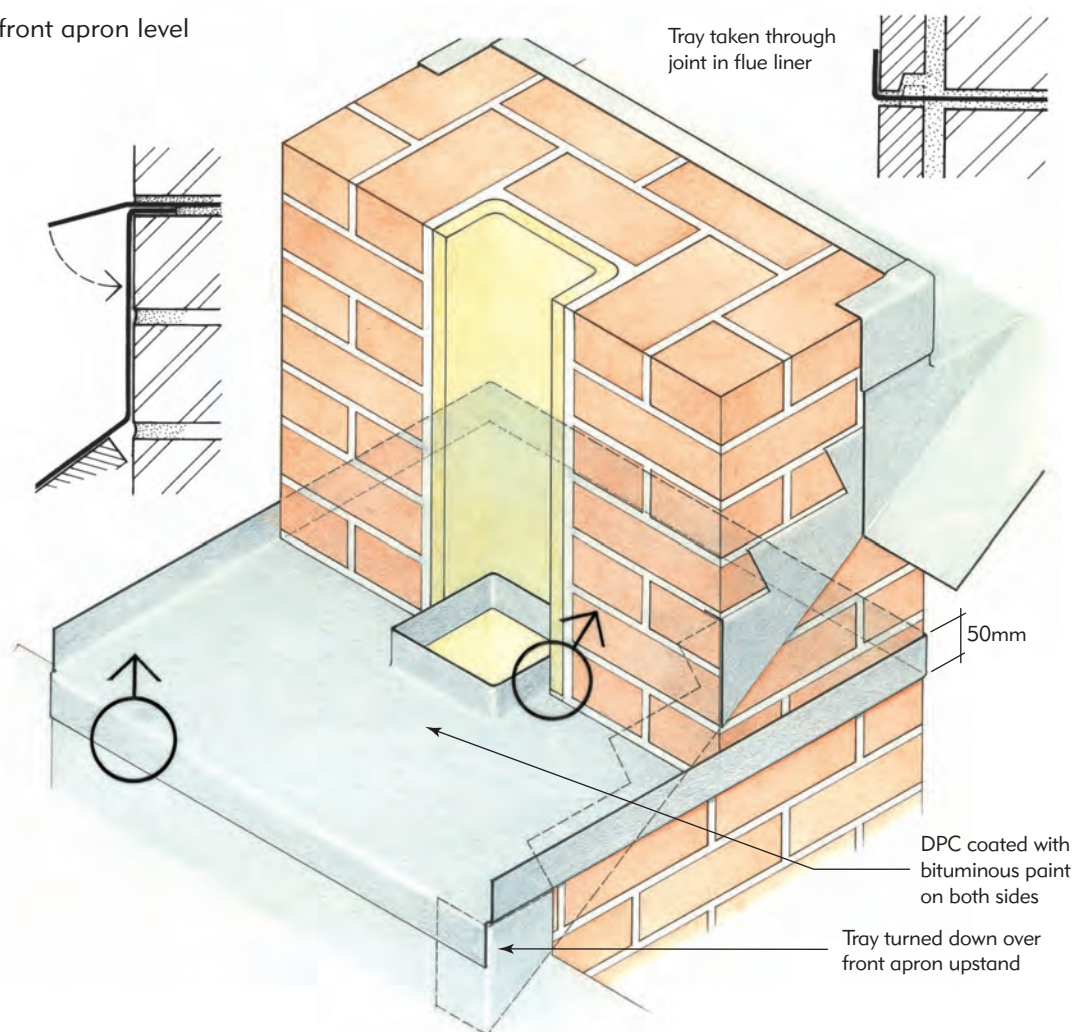


Fig 92. DPC at front apron level



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

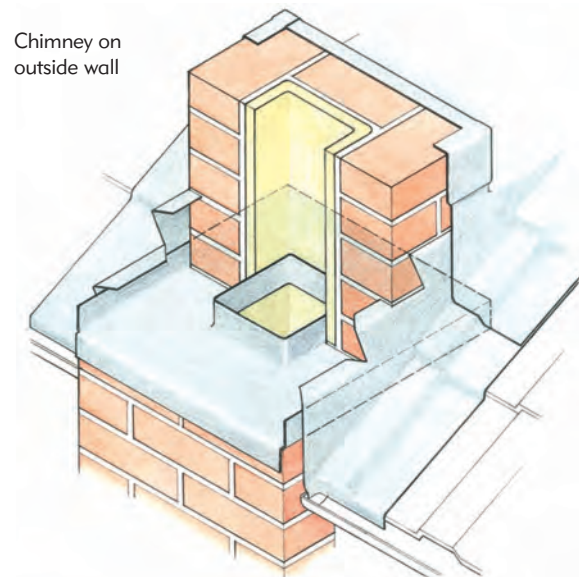


Fig 94. Chimney stack at ridge

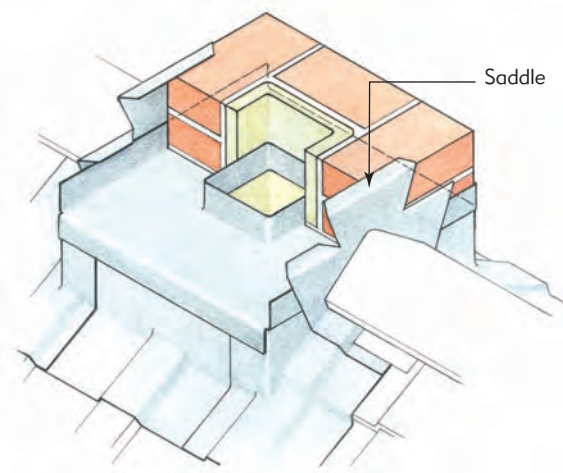
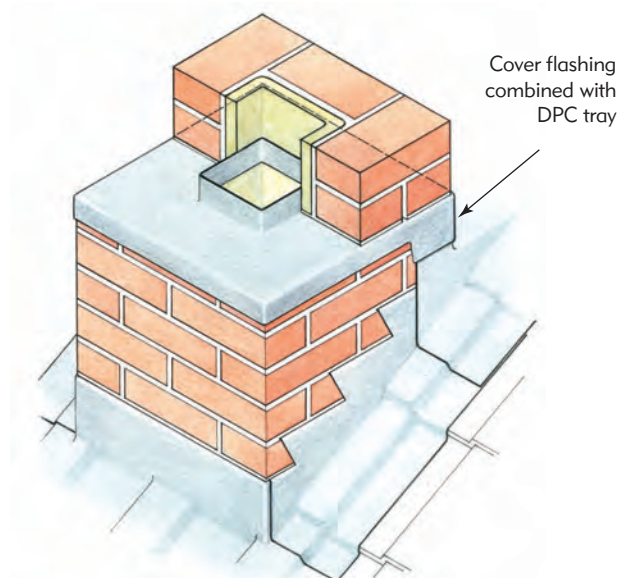


Fig 95. DPC at back gutter level



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

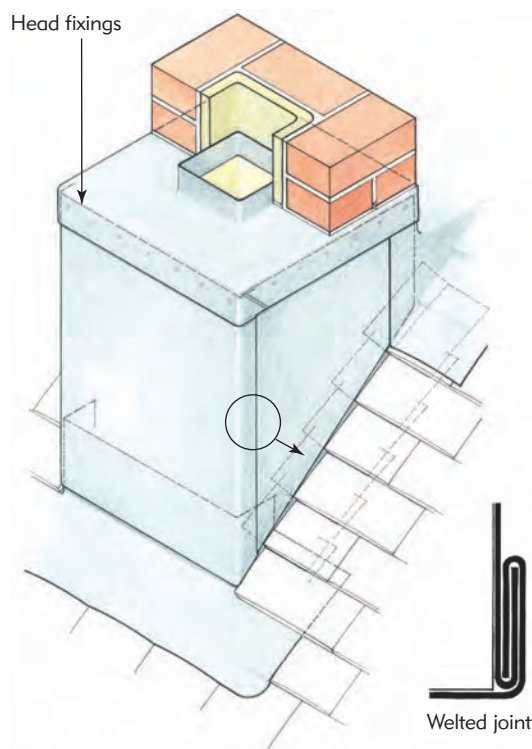
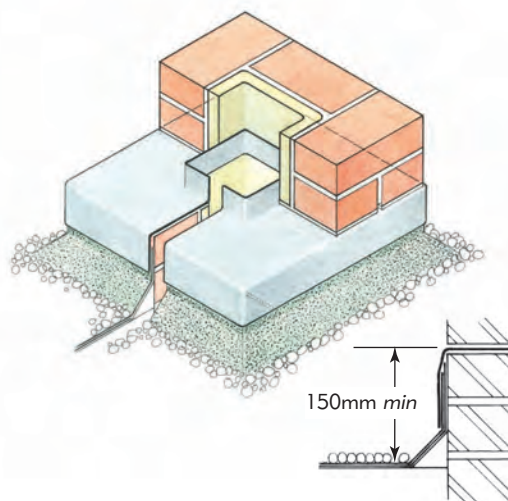


Fig 97. DPC to chimney through flat roof



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.

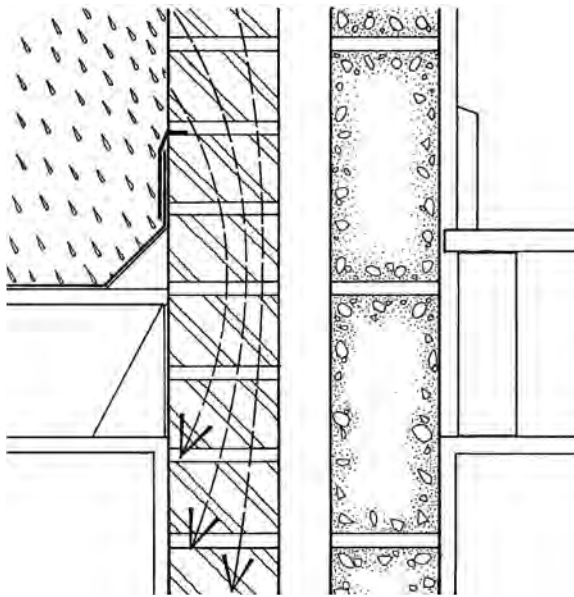
Lead sheet DPCs should be coated on both sides with bituminous paint to avoid the risk of corrosion by the free alkali in fresh Portland cement mortar (see page 11).

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.

DPCs (cont.)

Fig 98. Illustration of water penetration



'... the outer skin becomes an internal wall'

DPCs at raking abutments

With raking abutments in sheltered exposures, a lead sheet DPC, stepping course by course to follow the line of the roof, will prevent dampness from penetrating below the roof. Although there is no restriction on the length of the lead, pieces of about 2m will be found convenient with laps positioned in vertical joints, as shown.

In most situations however, it will be necessary to extend the stepped DPC across the cavity so that rainwater that penetrates down through the brickwork, or that runs down the inner face of the external skin, can be collected and discharged through weep holes.

It is essential that the stepped DPC be fitted in the correct position. This is best achieved by setting up a dummy rafter at the same pitch as the roof that will be subsequently constructed. The cavity wall is then built up (Fig 99) so that the distance between the top of the rafter and the internal corners of the stepped brickwork is as shown. The distance from the dummy rafter will therefore vary depending on the type of roof construction, thickness of battens and selection of tiles or slates. For typical profiled roof tiles, this distance would be 25mm (battens) plus, say, 65mm (thickness of two tiles) + 75mm = 165mm, whereas for slates this distance would be reduced to about 120mm.

For convenience of handling, the DPC should be preformed in lengths of about 1.5m, with laps arranged at a vertical joint. After coating with a bituminous paint, each DPC length must be bedded

and the horizontal mortar joints raked out to a depth of 25mm, so that the flashings can be fitted after the roof has been covered with slates or tiles.

To enable any water that collects in the cavity to discharge freely through the weep hole at the bottom of the abutment, it is important that the cavity is cleared of all mortar droppings during installation and subsequent construction of the brickwork above. With long abutments, particularly in exposed locations, it may be necessary to provide additional weep holes down the abutment.

Cavity trays

An alternative and usually more practical method of weathering a raking abutment is to use cavity trays. There are many types of preformed, proprietary cavity trays available but a simple tray made from lead sheet is shown in Fig 100. These can be prefabricated from code 4 and it is important to coat both sides of each tray with a bituminous paint before installation.

Again, the correct position for these cavity trays is best achieved by setting up a dummy rafter as in Fig 99, with similar allowances between the rafter and box corners. The bricklayer fits the cavity trays and the first tray, which is formed like a box, is positioned at the bottom of the roof slope. The function of this tray is to collect all the rainwater from the other trays and divert it via a weep hole to discharge above the slates or tiles. The subsequent trays are fitted, one per course, so that each tray overlaps the one below, thereby producing a linked DPC which will prevent penetration of water into the roof area below.

It is essential that the trays be well bedded in mortar and that mortar droppings are removed from the cavity during installation and subsequent construction of the brickwork above. To facilitate the fitting of the step flashings at a later time, it is important to rake out the mortar from under the cavity trays to a depth of 25mm to allow for the turn-in of the flashings, as shown.

Figure 100 also shows the flashings in position. Again, it is important to use only single-step flashings to ensure that rainwater that may percolate through the perpends at the box corners does not penetrate behind the upstand of the cover flashing.

DPCs (cont.)

Fig 99. Stepped DPCs to raking abutments of cavity walls (all exposures)

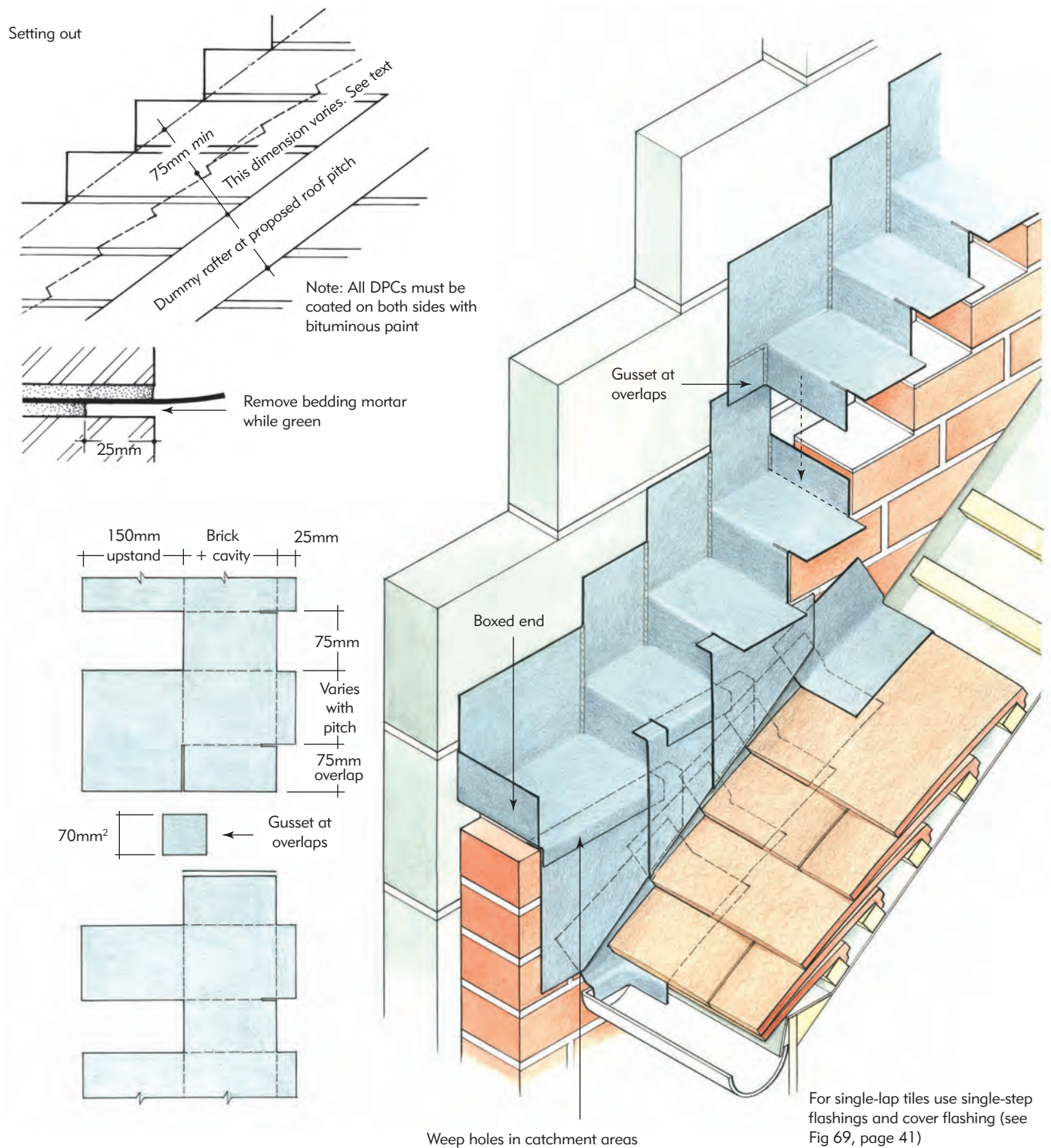
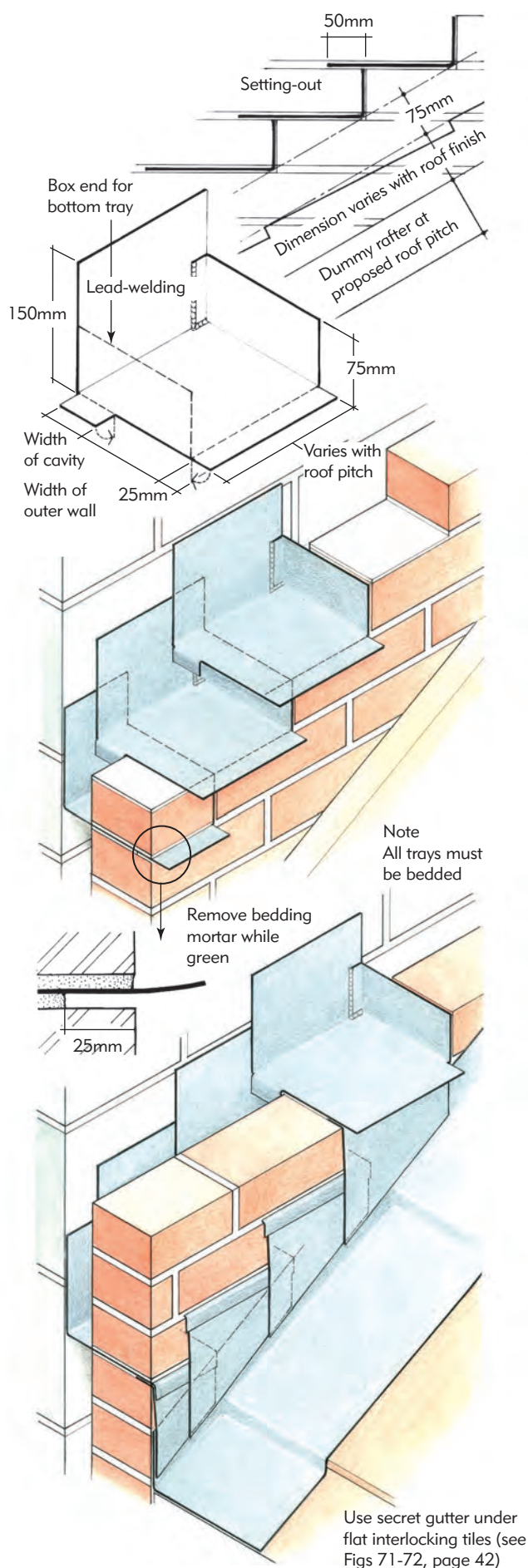


Fig 100. Cavity trays for raking abutments of cavity walls



DPCs (cont.)

DPCs at horizontal abutments

– existing buildings

When extending existing buildings, a lead sheet DPC can be fitted using prefabricated trays (Fig 103). To install these units, four bricks are removed at one end of the extension and the first tray is fitted. Three bricks are then refitted, leaving weep holes. The next three bricks are removed and the second tray, which has an overlap provided on the upstand, is fitted over the first. After refitting the next three bricks, this procedure is repeated until the DPC is completed. The final tray will have a box end similar to the first.

Note that the upstand that rests against the wall at the back of the trays is only 75mm high. When fitting trays into new buildings this upstand must always be 150mm due to the risk of a build-up of mortar droppings during subsequent work. However, with existing buildings, there is no such risk and, to avoid the removal of two courses of brickwork, the 75mm height shown would normally be adequate.

When installing this system of DPC trays, it is important to bed the trays and ensure that all bricks are refitted securely. If the existing mortar joints are very soft, it may be necessary to shorten the individual trays to a two-brick module instead of the three-brick one shown.

Note that the cavity DPC systems shown for both new buildings and extensions can be readily adapted to suit external block work or masonry.

DPCs at horizontal abutments – new buildings

In new construction, lead sheet is not normally used for a DPC at a horizontal abutment because of the requirement to use short pieces with joints to allow for thermal movement.

The use of long lengths of lead sheet DPC with lead-welded joints is not recommended because there are considerable variations in temperature within a cavity wall, which would cause them to buckle and form premature fatigue cracks. Unbonded laps would be unsuitable for expansion joints in a cavity wall and, except in sheltered exposures, the use of welts to join individual lengths of a horizontal DPC is not recommended. This is because any collection of rainwater on top of the DPC could submerge the welts and result in water penetration into the area below.

However, due to possible problems when fitting a DPC in juxtaposition with a cover flashing (Figs 29-34, page 25), there are occasions when a lead sheet DPC combined with a cover flashing is desirable. With horizontal abutments, it is important to fit the DPC at the correct height above where the flat or pitched roof will subsequently abut the wall.

DPCs (cont.)

DPCs at horizontal abutments

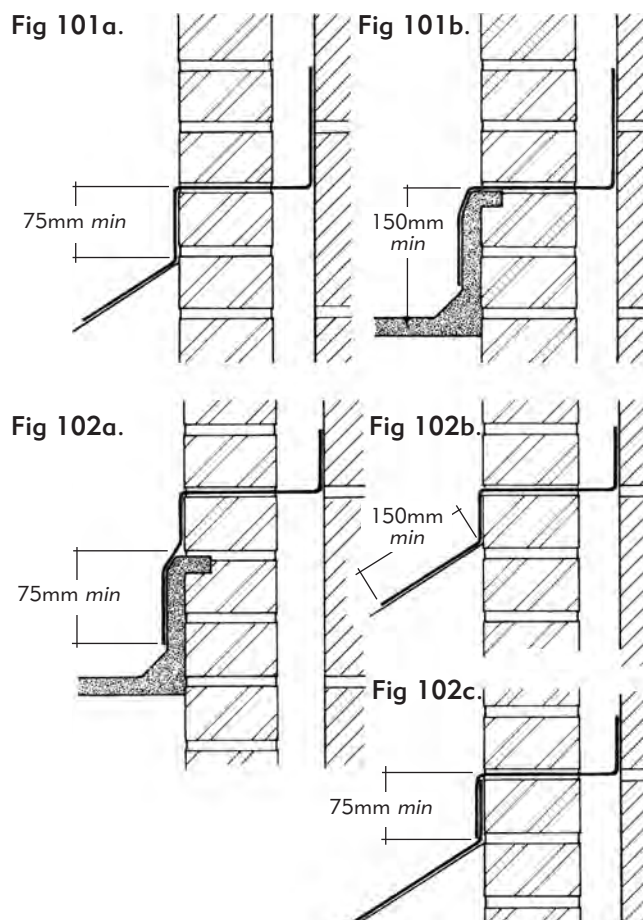
– new buildings

For slated or tiled pitched roofs, the height of the DPC above the roof covering should not be less than 75mm (Fig 101a), and for felt roofs not less than 150mm above the roof surface (Fig 101b). When external insulants are used on asphalt and built-up bituminous felt roofs, it will be necessary to increase this height by 50-75mm, depending on the thickness of the insulating materials.

The DPC is prefabricated in lengths not exceeding 1.5m, coated on both sides with bituminous paint and then fitted as shown in Fig 104, with the upstand positioned in vertical joints in the brickwork. Note that the overlap of the upstand is bossed at the front to provide a cover over where the trays abut, thereby avoiding any risk of water penetration where the tray becomes a cover flashing.

It is important to bed each piece of DPC and during subsequent construction of the wall the cavity must be kept clear of mortar droppings so that any water that collects in the trays can discharge freely through the weep holes. A strengthening gusset is welded to the centre of each DPC tray and a minimum of two weep holes should be spaced between the upstands.

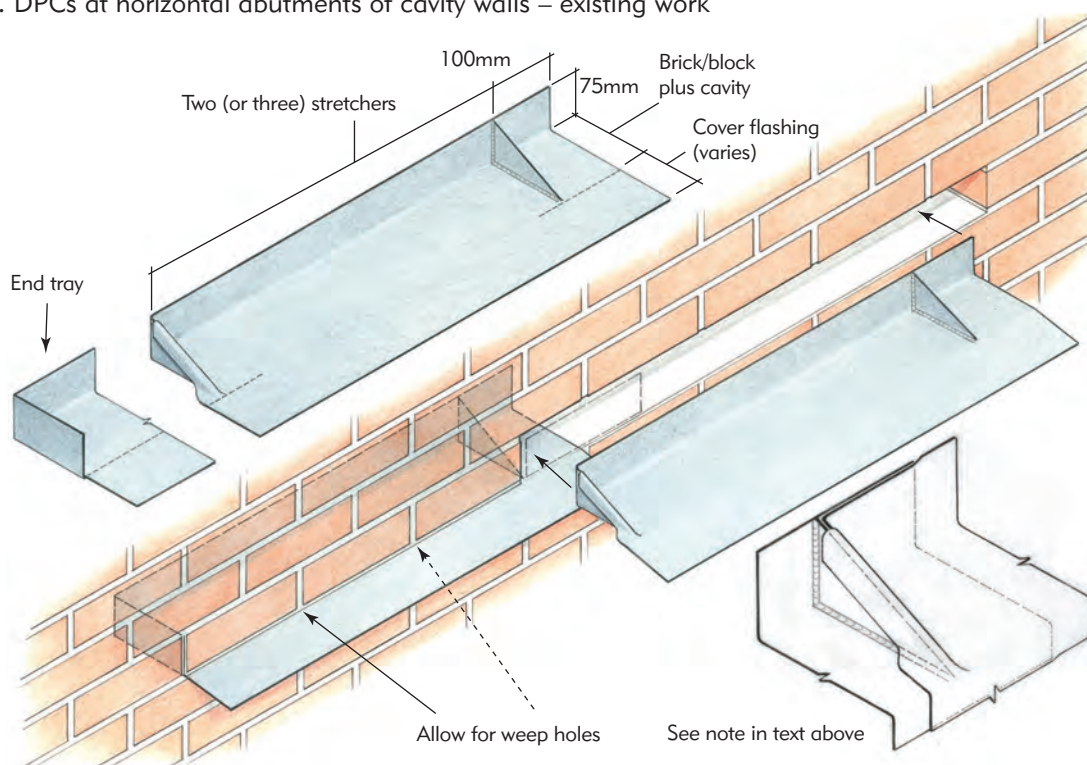
The width of the exposed section of the trays (cover flashings) will depend upon the type of abutting roof – that is, flat or pitched. For flat roofs covered with asphalt or built-up bituminous felt, the extension will normally be about 150mm to provide for a minimum cover over the roof upstand of 75mm (Fig 102a).



On pitched roofs, the extension must provide for a cover of not less than 150mm over the slates or tiles (Fig 102b) or, alternatively, an apron flashing can be used with a 75mm-minimum vertical cover (Fig 102c).

The cavity DPC systems shown for both new buildings and extensions can be readily adapted to suit external blockwork or masonry.

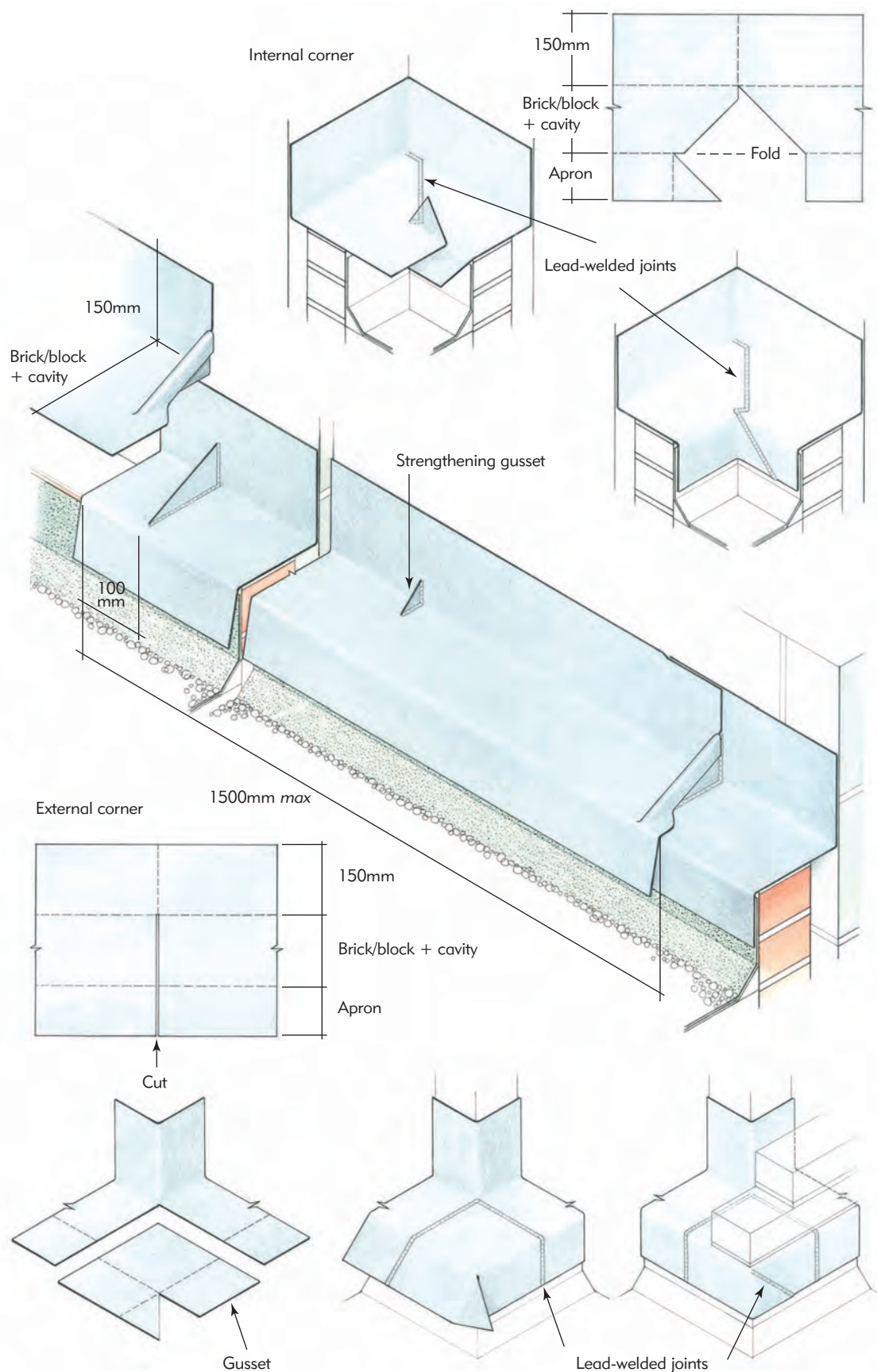
Fig 103. DPCs at horizontal abutments of cavity walls – existing work



Damp-proof courses (continued)

DPCs at horizontal abutments – new buildings

Fig 104. DPCs at horizontal abutments of cavity walls – new work

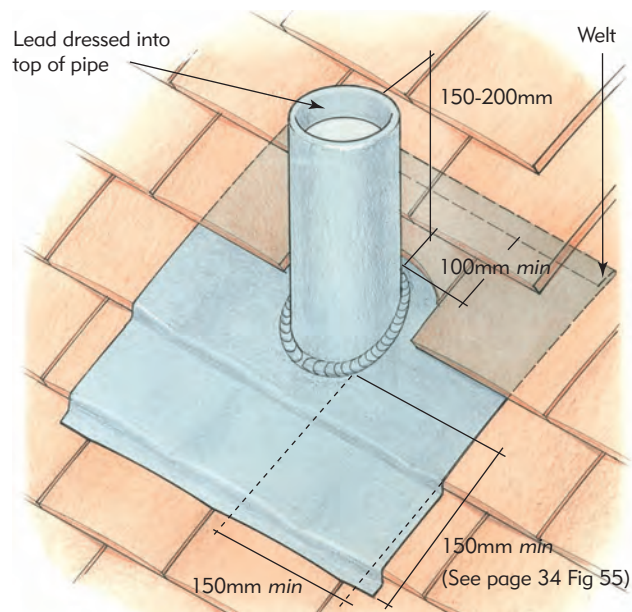


Lead slates and sleeves

The flashing used where a pipe or structure penetrates a roof is known as a lead slate – so called because it was originally designed to course in with slated roofs.

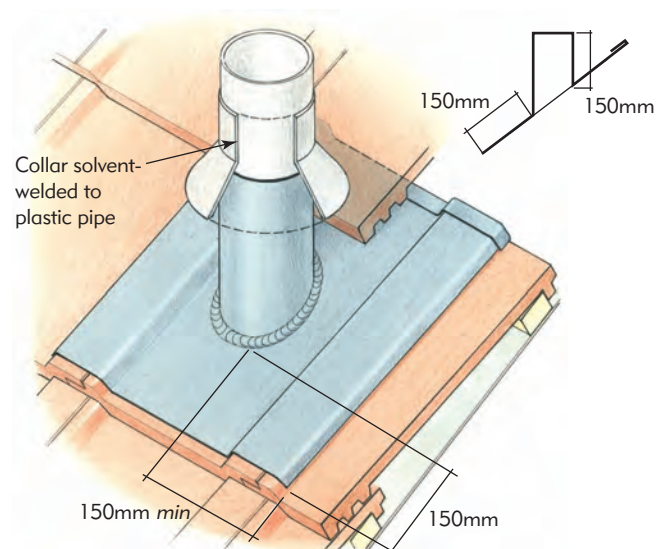
Although lead slates can be formed by bossing from a single piece of lead sheet, it is more practical and certainly more economical to fabricate them by lead-welding.

Fig 105. Lead-welded lead slate to cast-iron pipe



The size required for the base of the slate will vary according to the type of roof covering and the diameter of the pipe. For standard plain tiles and slates with a 100mm-diameter pipe, a width of 400mm should be adequate. The base should extend a minimum 150mm in front of pipe dependant on pitch (see page 34 fig 55) and from the back to terminate not less than 100mm under the tile or slate. With single-lap tiles, it may be necessary to increase the width to 200mm on each side of the pipe for dressing into the contours. The top edge under the tiles is finished with a welt (Fig 105). Code 4 is the usual thickness of sheet to use for lead slates.

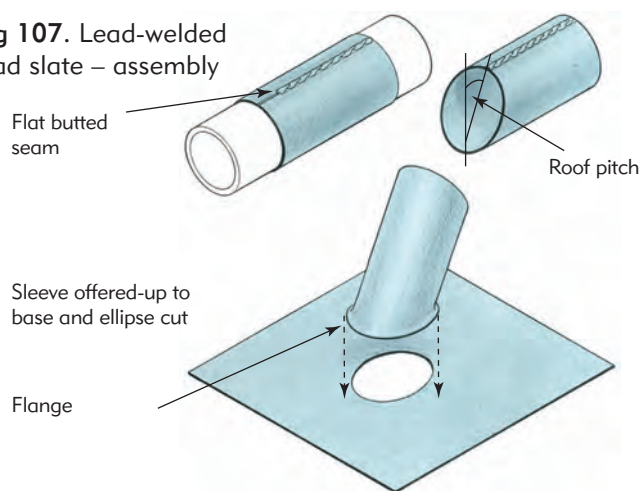
Fig 106. Lead-welded lead slate to plastic pipe



Upstand heights will vary but should not be less than 150mm at the back. If the pipe is cast iron, it can be cut to leave a plain end. The upstand of the lead slate is then simply dressed into the top of the pipe to provide a weather-tight finish.

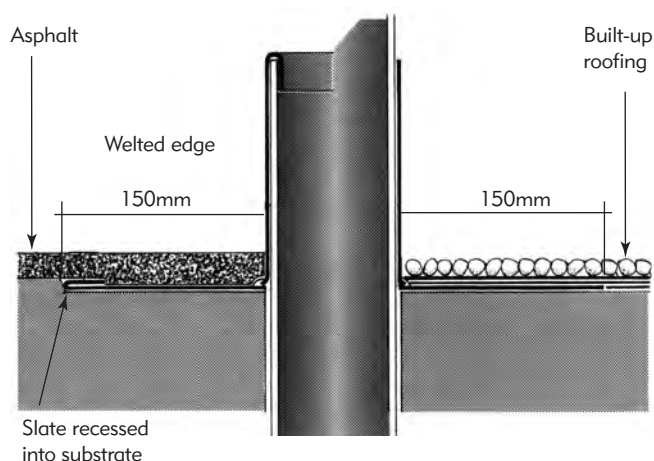
For plastic pipes, collars are available that are solvent-cemented to the pipe to provide a weathering over the lead upstand (Fig 106). Where cast-iron pipes extend more than about 300mm above the roof, special joints are also available that allow the lead sleeve to extend under a cast-iron weathering collar.

Fig 107. Lead-welded lead slate – assembly



Lead slates can be purchased from a builder's merchant ready-made to suit most pipe sizes and roof pitch. However, they can also be made on site as follows. A piece of lead, wide enough to give the required height of the upstand – including a turn-in at the top where applicable – is cut to a length equivalent to the external circumference of the pipe, plus about 5mm for tolerance. The upstand is turned round a piece of rigid pipe and the meeting edges lead-welded together with a flat butted seam (Fig 107). One end of the sleeve is then cut to the required roof pitch and the edge dressed to form a flange that is placed on the base. The hole is marked and cut, and the sleeve welded to the base with a flat lapped seam.

Fig 108. Lead slates to asphalt and built-up surfaced flat roofs

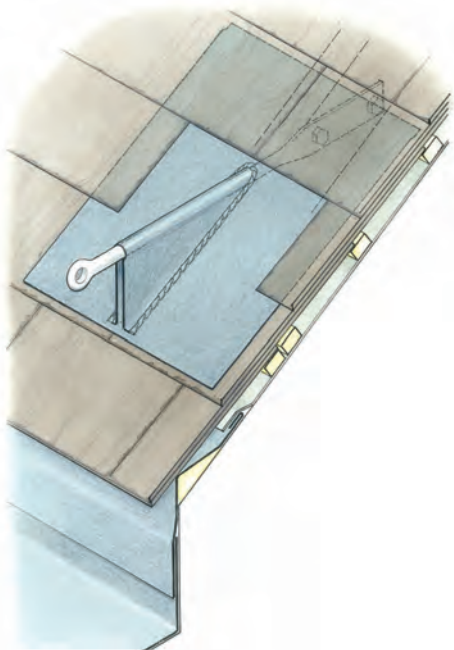


Lead slates and sleeves (cont.)

Where a pipe penetrates a flat or pitched lead-covered roof, the sleeve is lead-welded directly onto the roof covering. For pipes penetrating flat roofs covered with asphalt or bituminous felt, the base is bonded into the roof covering as shown in Fig 108. In all cases, the upstands are made weather-tight at the top as described above for lead slates.

Overflow pipes, stays and so on that penetrate tiled or slated roofs can be made weather-tight with lead slates (Figs 109-110).

Fig 110. Lead slate for penetration of roof by safety cable anchorage



Fixing blocks for supporting rainwater or other pipes can be weathered as shown in Fig 111. The shape required is best formed on the bench by cutting, folding and lead-welding.

Fig 111. Lead flashing to fixing block through tile hanging

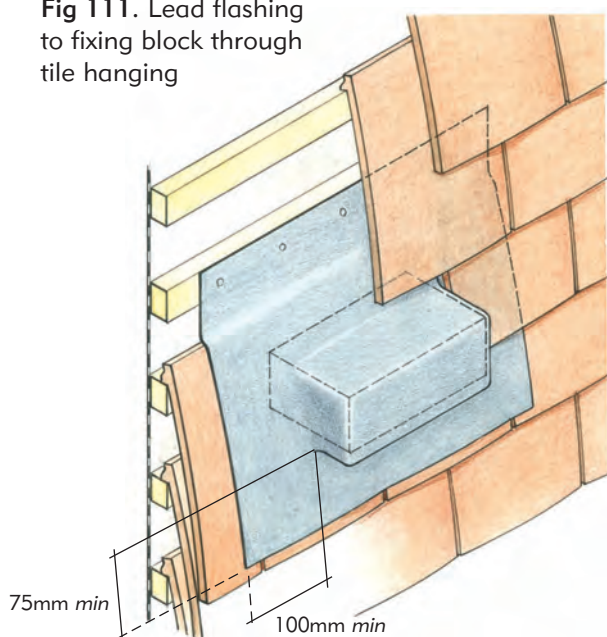
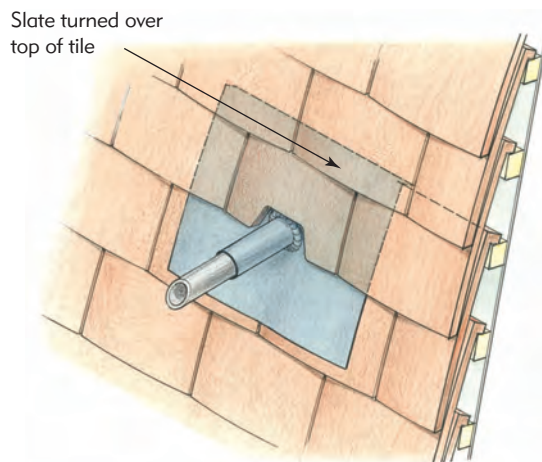


Fig 109. Lead slate to overflow pipe



Situations also arise where structural steel members penetrate roofs, and many methods of forming lead weathering with lead-welded seams can be devised. Examples are shown in Figs 112a and b. The two pieces of flashing required for each application are cut and lead-welded on the bench. When the stanchion is located as in Fig 112a, the two pieces can be lapped as shown, but the lap must be lead-welded if the pitch is 10° or less. The two flashing pieces must also be lead-welded for all pitches if the stanchion is aligned with the slope as in Fig 112b. Where the web of the stanchion is across the slope (Fig 112a), it will be necessary to fill the profiles of the roof sheeting to prevent a build-up of water behind the web.

Fig 112a. Prefabricated lead slate to stanchion penetrating a roof (web against roof slope)

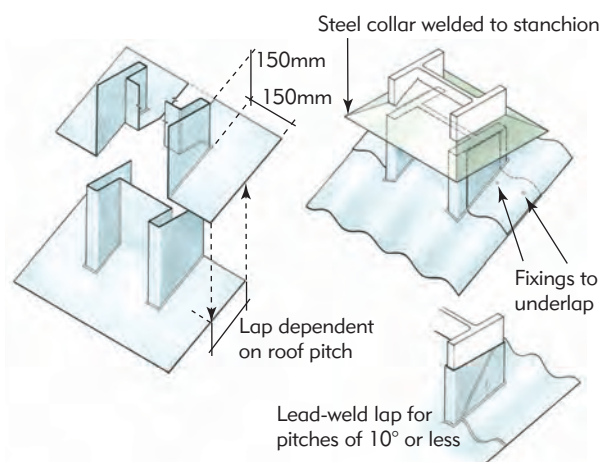
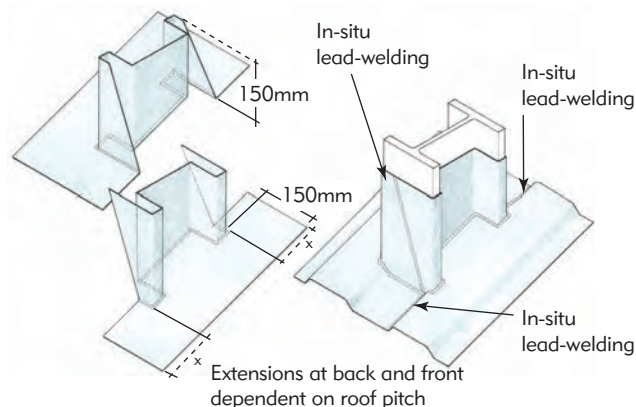


Fig 112b. Prefabricated lead slate to stanchion penetrating a roof (web with roof slope)



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).

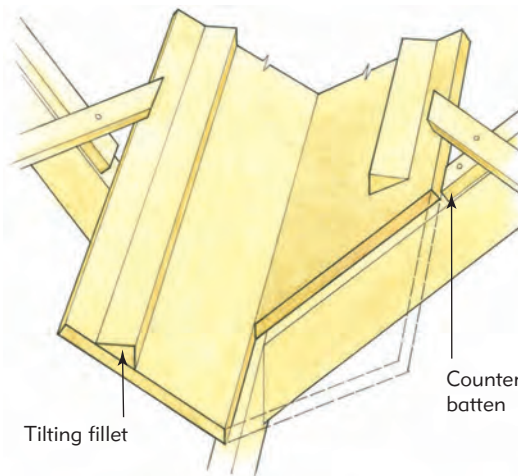
Although the traditional valley gutter width of 125mm has proved to be satisfactory for all normal areas of slated and tiled roofs, tests have shown that the gutter sizes need to be related to the roof pitch, design rainfall rate and the catchment area. In many cases, a gutter width of 100mm will be 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

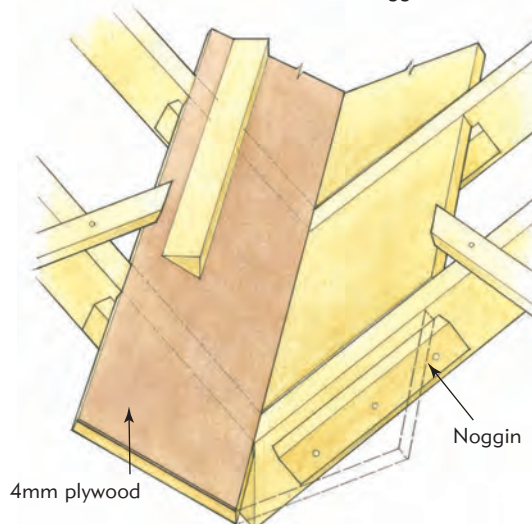
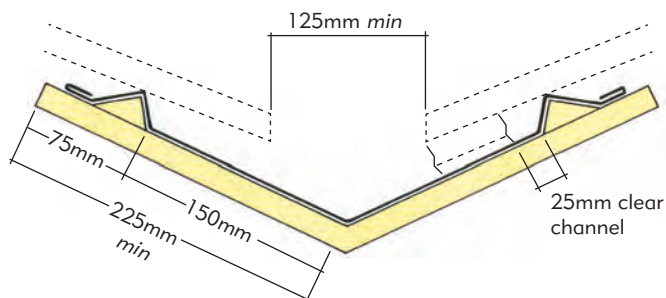


Fig 114. Key dimensions



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

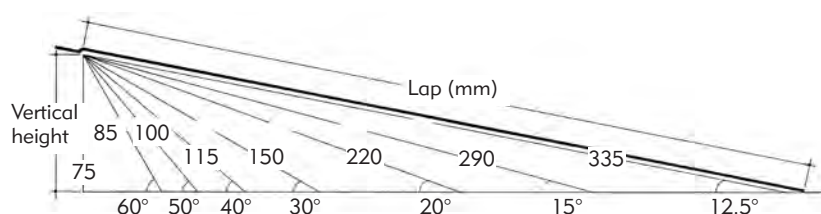
Table 4 shows the recommended width of valley gutters for a once in 50 year rain event. The rate should be compared with charts in the National Annex of BS EN 12056-3:2000 and BS EN 5534:2014

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

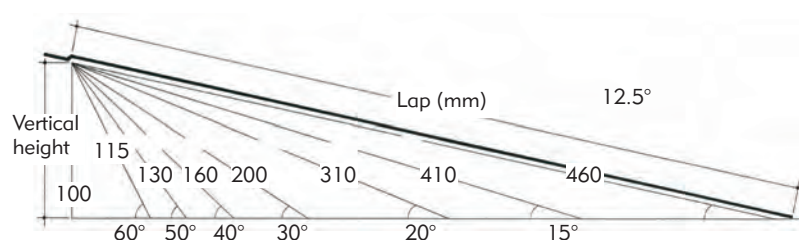
- Plan area, not actual area of the roof
- A maximum rafter length of 10m measured on plan.

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



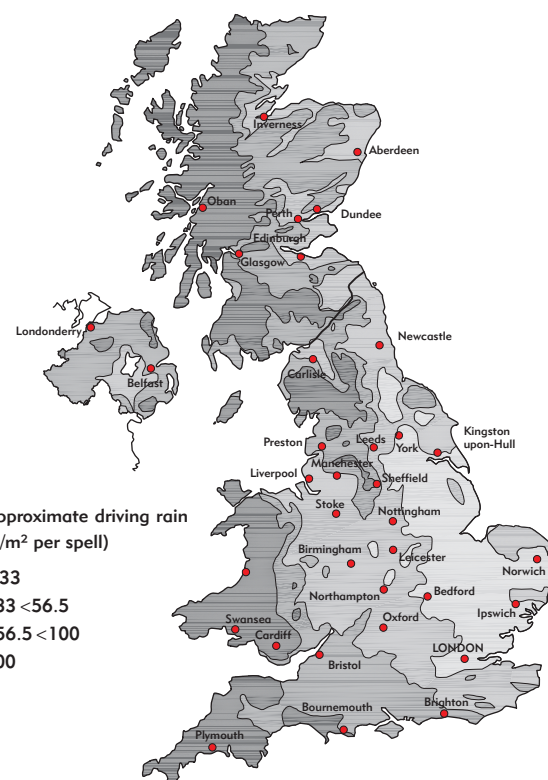
Laps for roofs in severe and very severe exposure locations

Key Exposure zone

- Sheltered
- Moderate
- Severe
- Very severe

Approximate driving rain (L/m² per spell)

- <33
- ≥33 <56.5
- ≥56.5 <100
- 100



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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

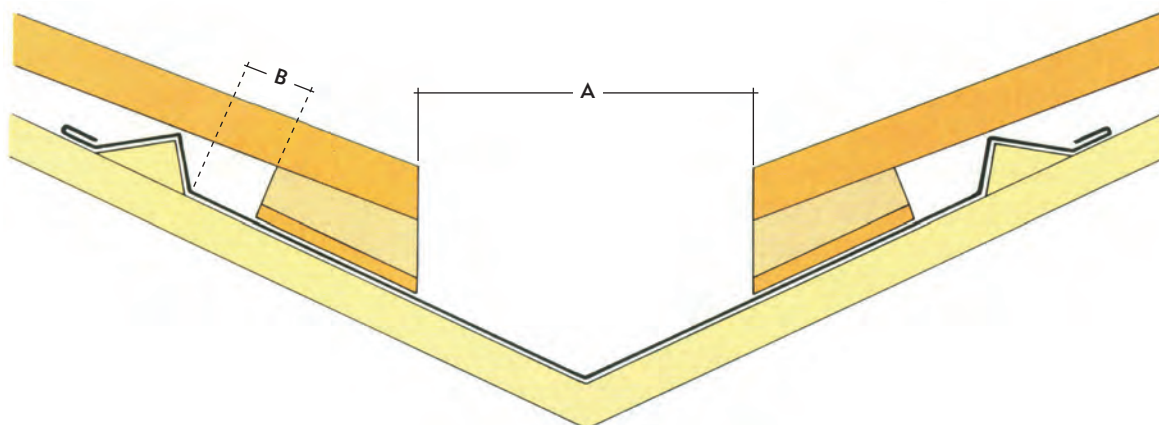


Table 5. Dimensions for pitched valleys with bedded tiles

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

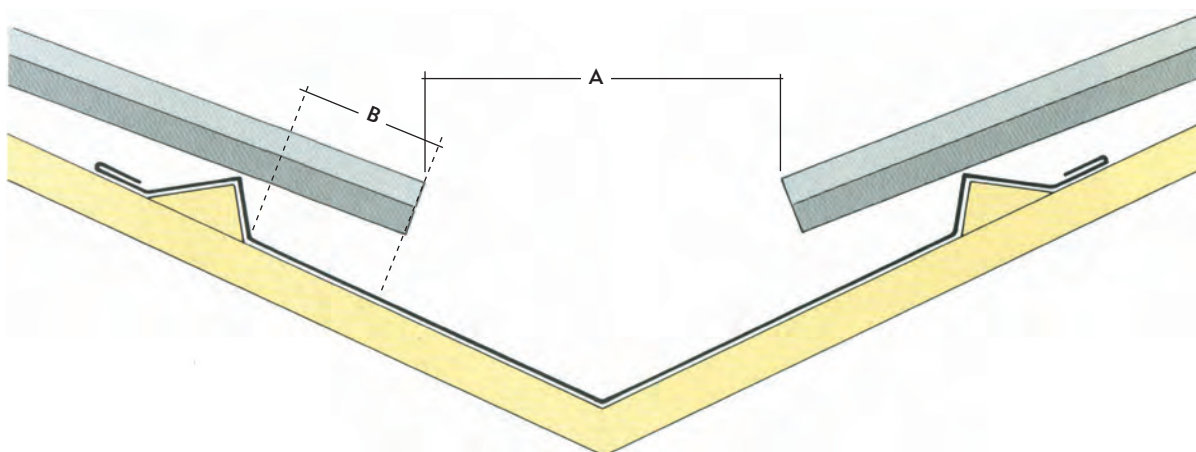
Fig 115 shows a cross-section of a valley gutter and Table 5 indicates the key dimensions for valleys with bedded tiles.

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.

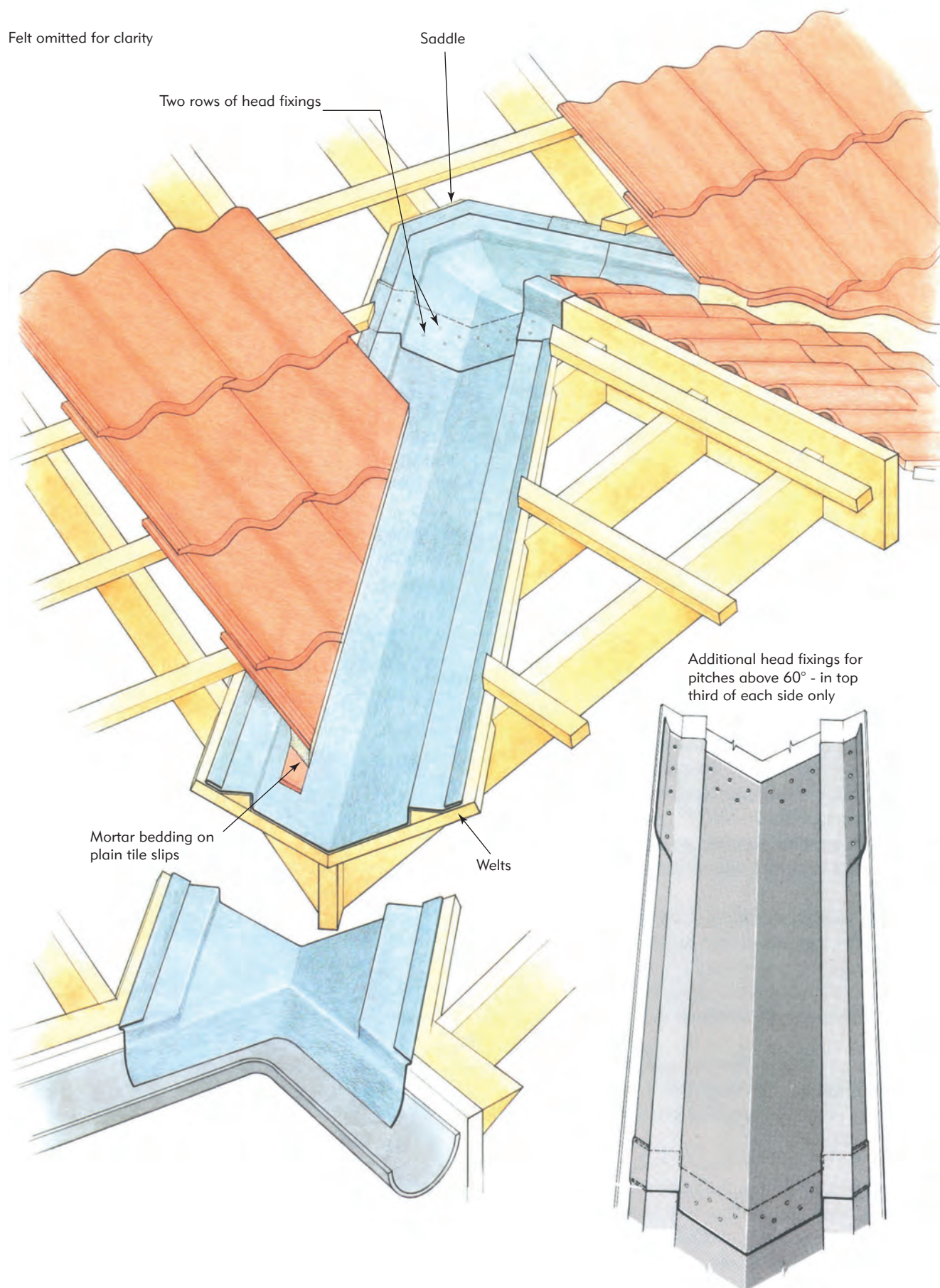
Fig 116. Valleys with unbedded tiles or slates



Pitched valley gutters (cont.)

Fig 117. Lead-lined pitched valley gutter and saddle

Felt omitted for clarity



Pitched valley gutters (cont.)

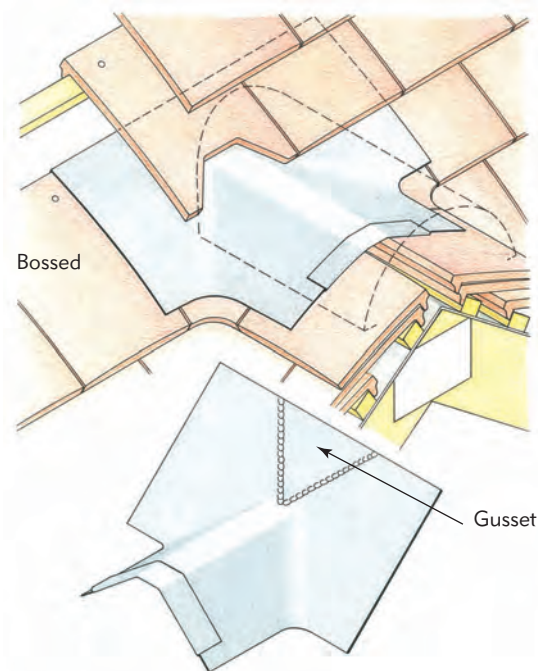
The lead linings are laid directly onto the valley boards. It is important that the bituminous sarking felt beneath the tiles is not carried into the sole of the gutter as an underlay to the lead because of the risk of the felt softening during the summer. This would cause the lead to stick to the substrate,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

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.

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.

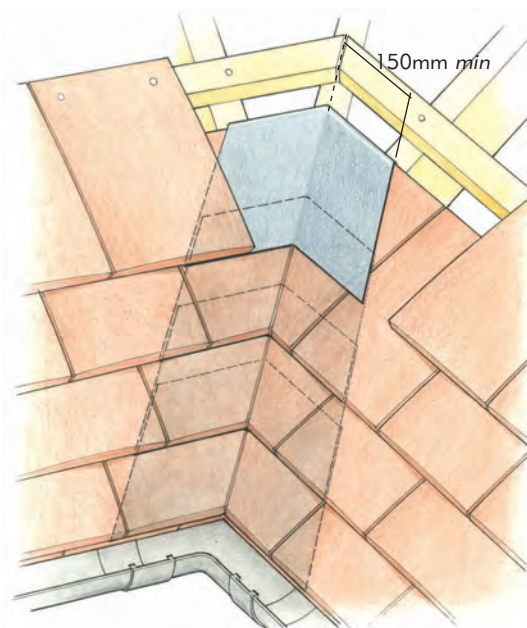
For pitches of 45° and over, the soakers are fitted one to each course of tiles or slates. At the intersection of the valley with a ridge, a lead saddle (Fig 118) is fitted.

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 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.

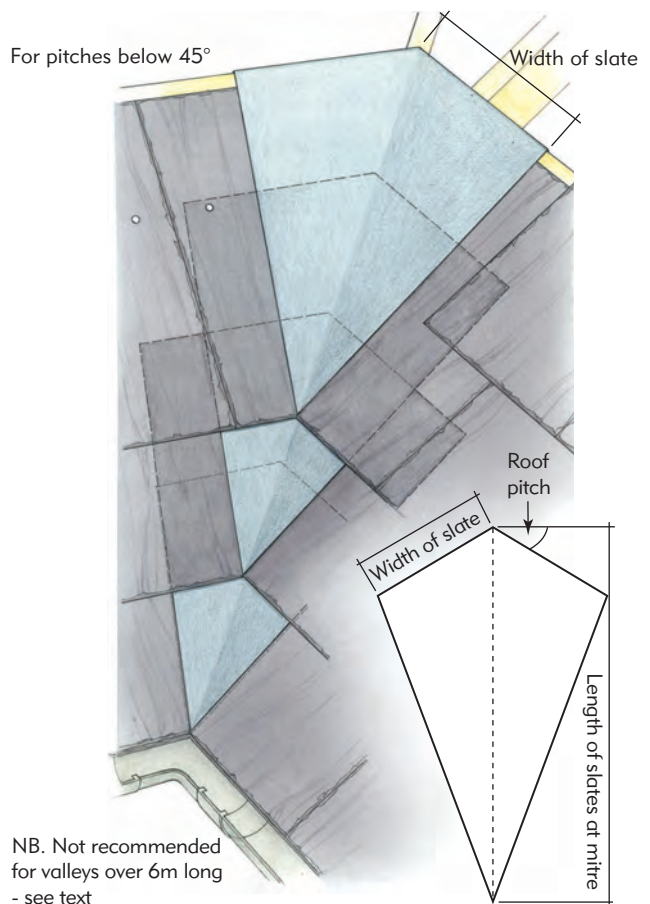
Pitched valley soakers (cont.)

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.

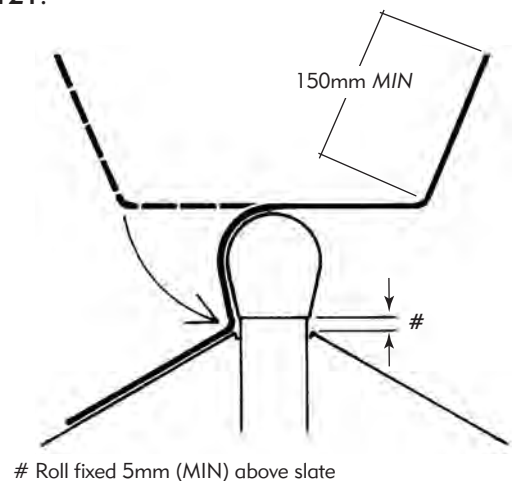
The minimum size and shape for wood rolls is shown in Fig 2 (page 13).

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.



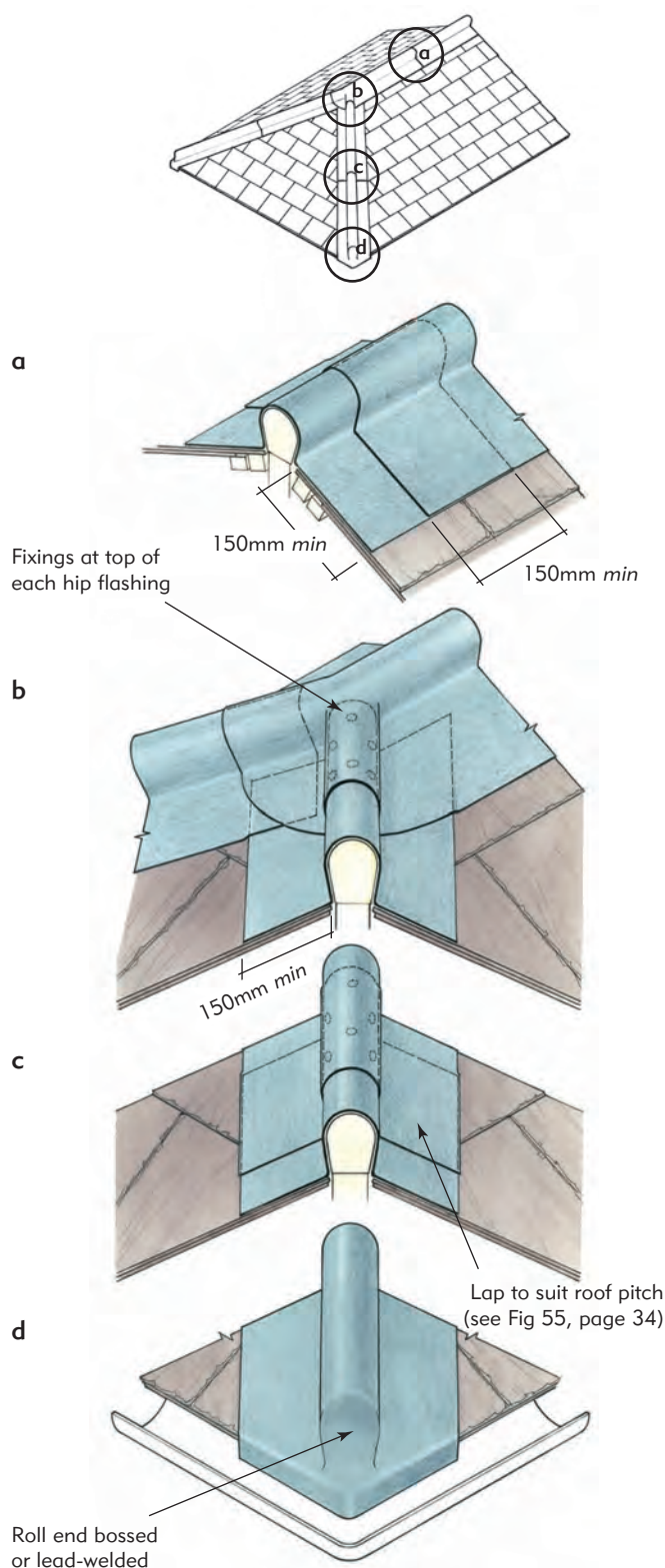
thicker. All hip flashings should be fixed in lengths not greater than 1.5m.

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



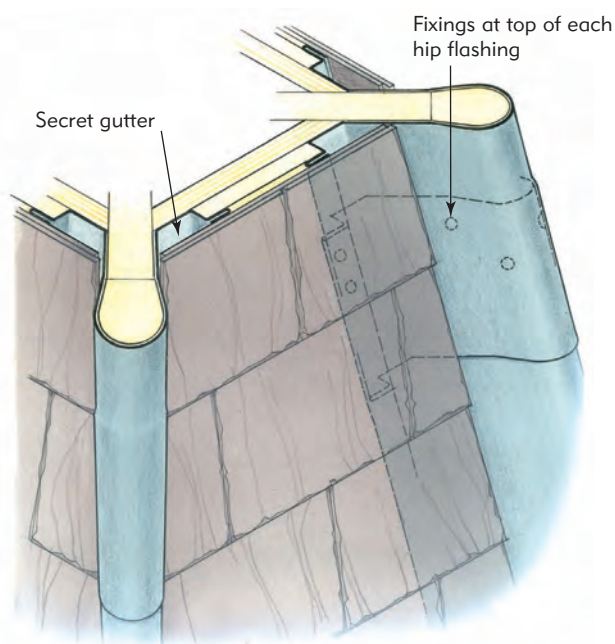
and fixing of clips, refer to 'Fixing clips', pages 26-28.

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.

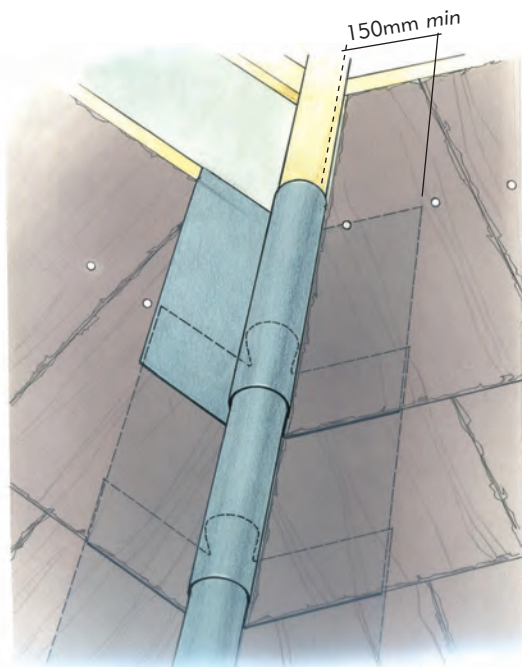
Fig 123. Wood-cored roll hips to spires



Ridge and hip soakers

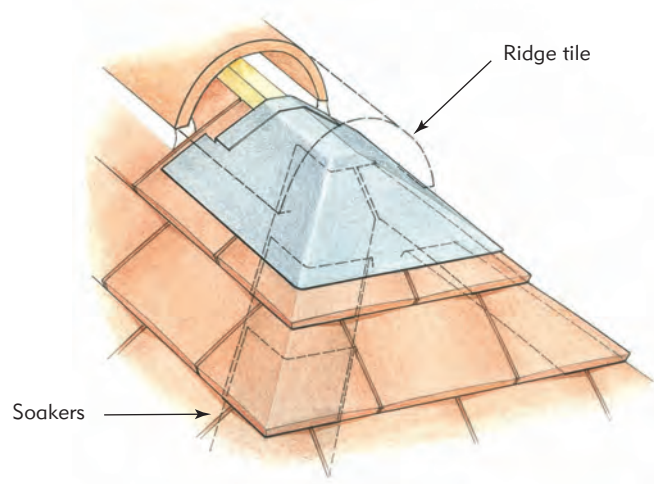
A variation of this hip weathering on double-lap plain tiled or slated roofs is to use soakers as shown in Fig 124. This is suitable for all roof pitches and code 3 can be used for the soakers, although code 4 may be preferred when the roof is covered with large, thick natural slates.

Fig 124. Hip roll soakers (shown with slates)



On plain double-lap or slated roofs with mitred hips, the parallel-sided soaker can also be used, but without the wood roll. Fig 126 shows the hip soakers in position with the top edge of each soaker turned 25mm over the top of the tiles. Hip soakers are suitable for all roof pitches and should extend not less than 100mm on each side of the mitre. For slated roofs below 35° this should be increased to 150mm (Fig 127).

Fig 125. Lead saddle at ridge-to-hip intersection



When using ridge tiles, a lead saddle is used to weather the intersection between the mitred hips and the ridge (Fig 125).

Fig 126. Soakers to mitred hips

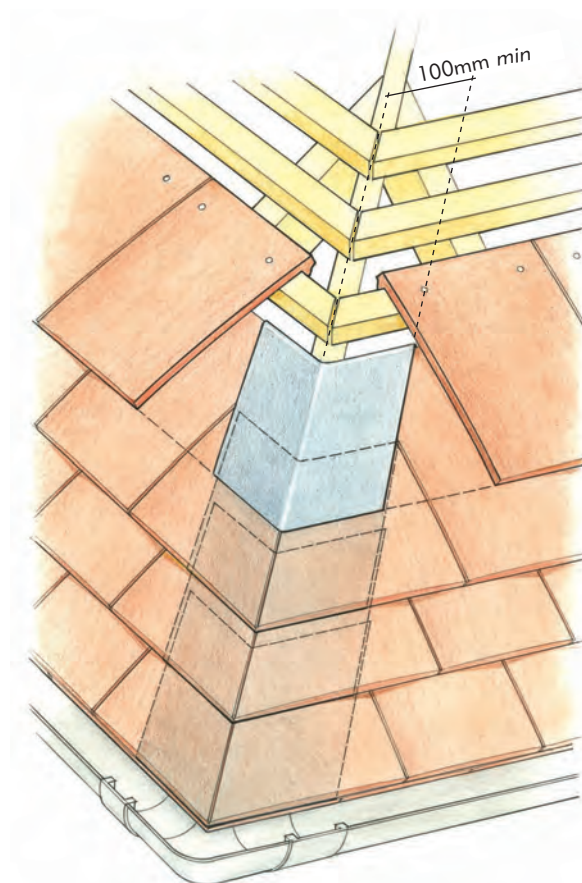
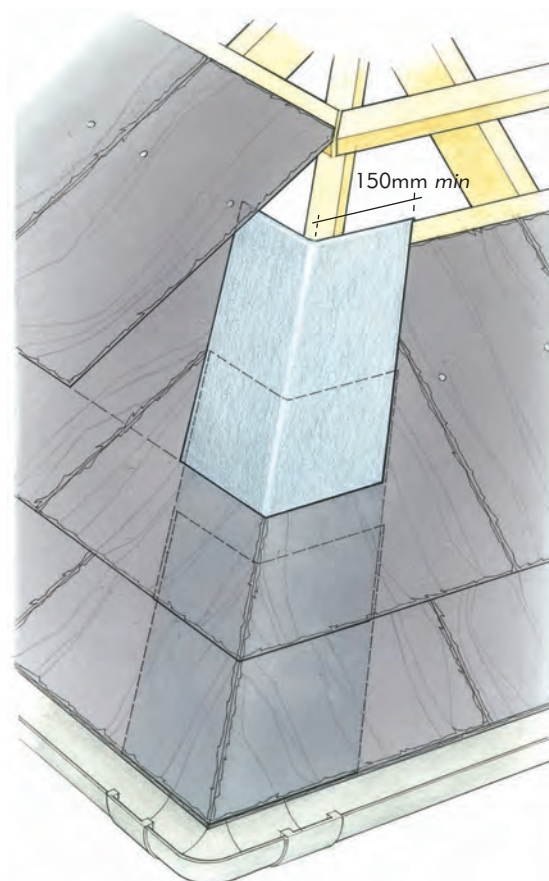
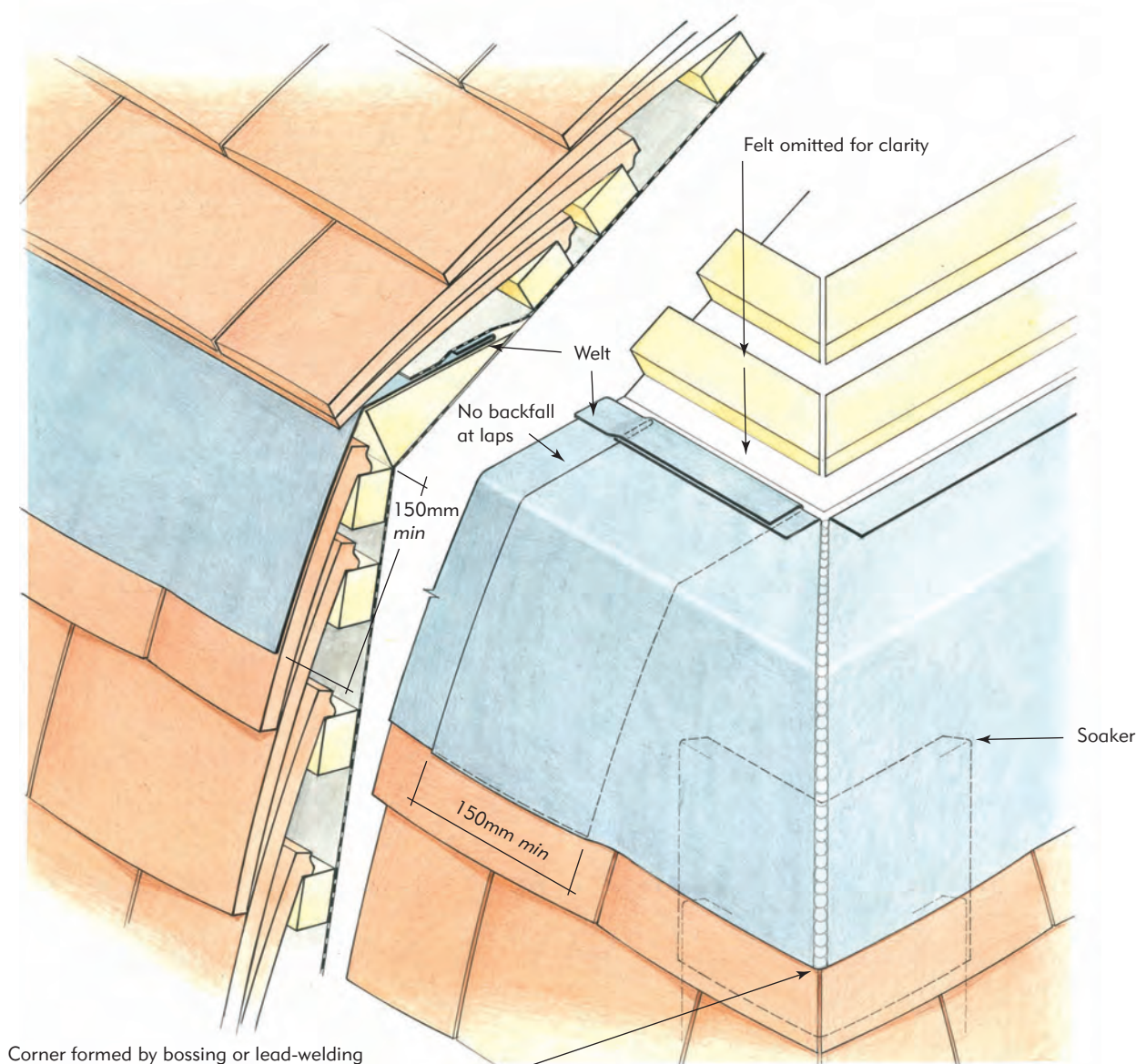


Fig 127. Soakers to mitred hips (pitches below 35°)



Flashings to mansards and changes in roof pitch

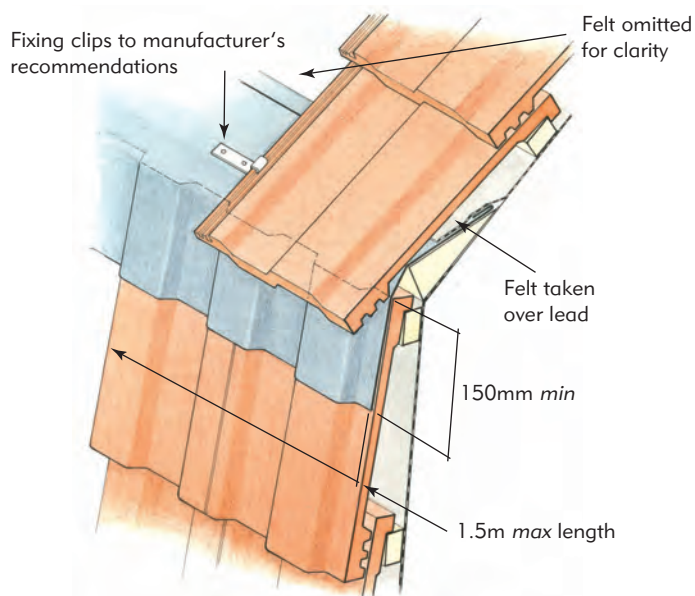
Fig 128. Typical flashing to mansard roof with double-lap plain tiles



A simple form of mansard flashing (Fig 128) allows for a 150mm extension over the tiles or slates on the lower roof and 150-200mm up the slope of the upper roof. Flashing lengths should not exceed 1.5m and each piece is copper-nailed at the top at about 150mm centres. Laps between pieces should be not less than 150mm. It is important to fit a lay board and timber fillet as shown to provide support for the lead and also for the bottom row of tiles. This detail is suitable when using double-lapped plain tiles or slates.

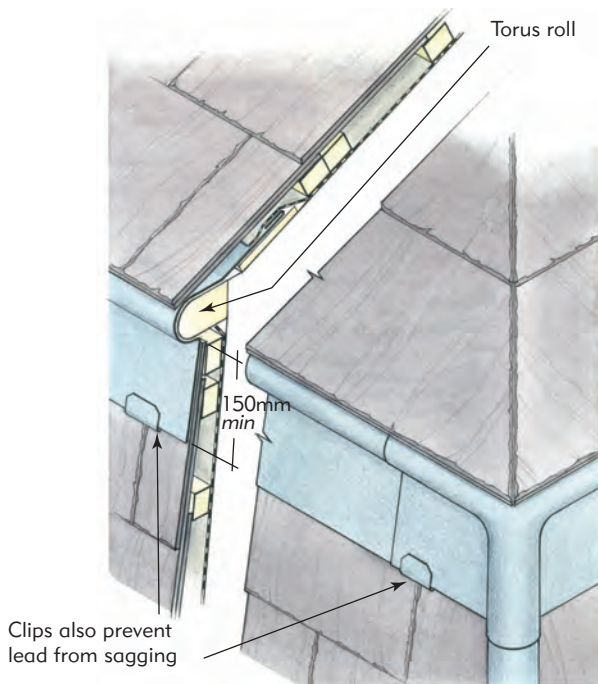
Fig 129 shows a similar detail for single-lap tiles. It is essential to follow the manufacturer's fixing instructions to prevent the tiles from lifting at the intersection in high winds.

Fig 129. Flashing to change of pitch with profiled tiles



Flashings to mansards and changes in roof pitch (cont.)

Fig 130. Torus roll flashing to slated mansard roof



A common practice with slated roofs is to fit a torus roll at the intersection (Fig 130). Although the spacing and fixing of clips along the free edge of all mansard flashings is important, clips are particularly necessary in this case because they also prevent the lead from sagging away from the underside of the roll.

Where the mansard flashings intersect with the hips, several combinations of detail can occur, as shown in Figs 128, 129 and 131. Although most of these junctions can be formed by bossing, they are usually easier to fabricate by lead-welding.

Flashings are required where a roof changes pitch and also where a vertical surface meets a pitched roof below. Figs 132a and b show typical flashings for these situations. The tilting fillet should be slightly raised to prevent the tiles chaffing the lead sheet.

Fig 131. Flashing to hip intersection with profiled tiles

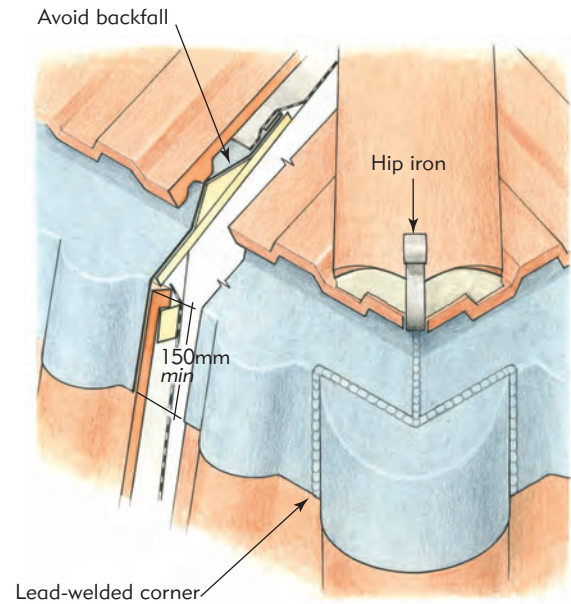
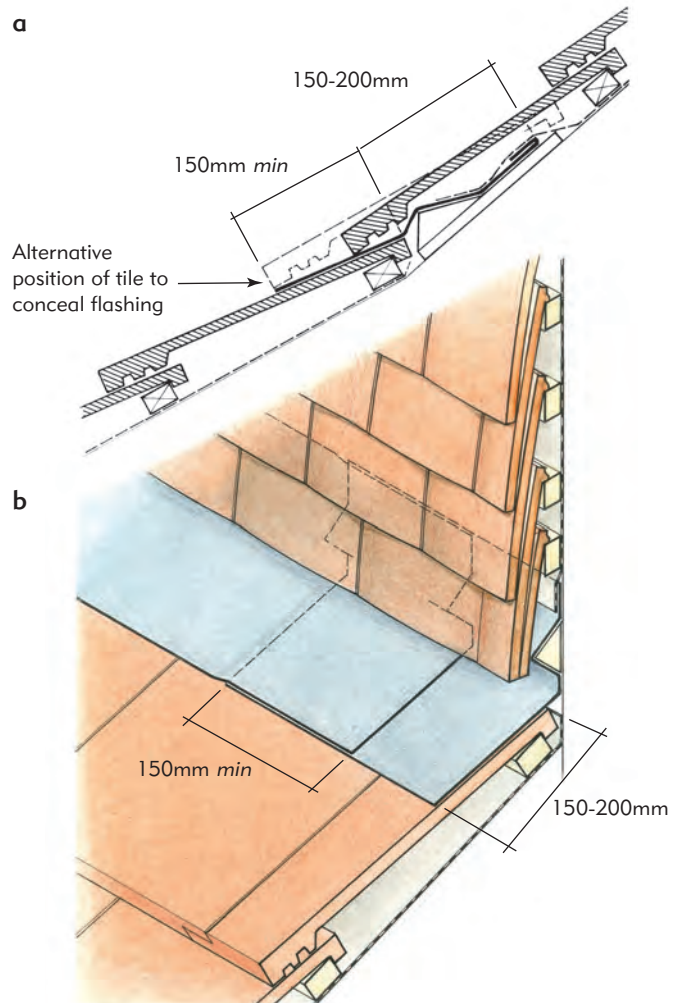
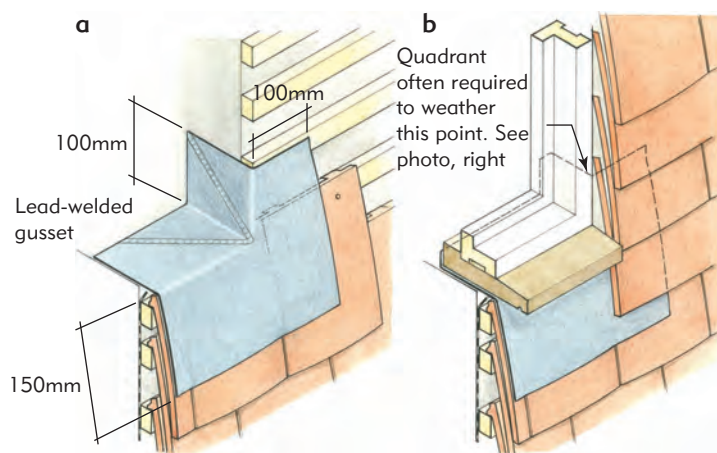


Fig 132. Typical flashings to changes of roof pitch



Flashings to tile and slate hanging

Fig 133. Typical sill flashings in tile hanging



Tile and slate hanging is a traditional external wall finish that is often also used in modern building. It is a speedy form of dry construction that blends in well with brickwork to provide pleasing variations in design on both large and small buildings.

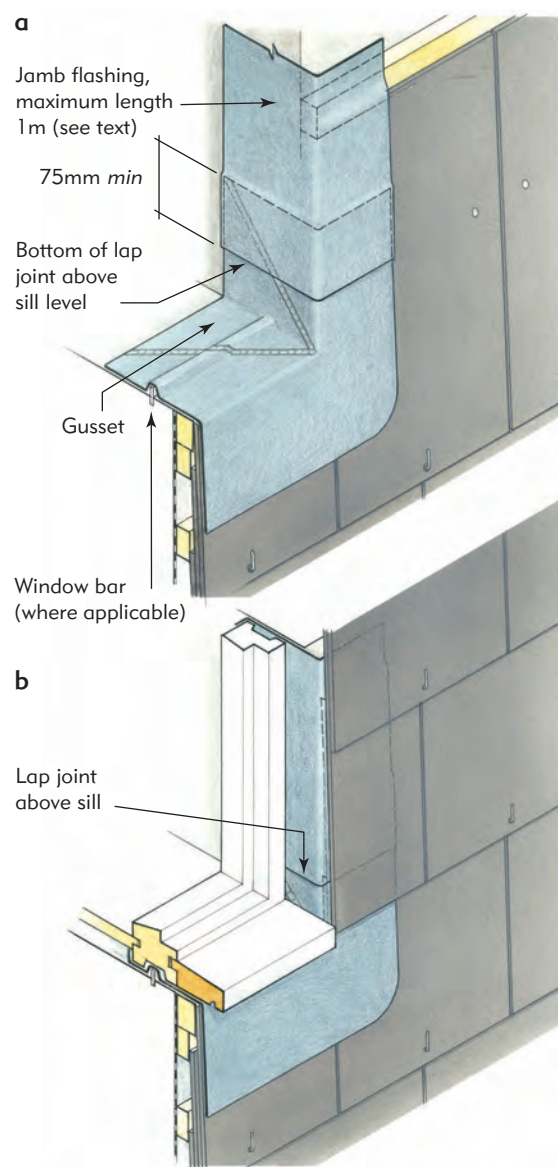
At the head of spandrels of tile or slate hanging, a lead apron is fitted under the projecting sill of the window. A typical flashing over tiles is shown in Fig 133a. Although the sill corners can be bossed, it is usually easier and quicker to fabricate using a lead-welded gusset. Fig 133b shows the window in position with the front of the stile abutting the tiles. Pointing the tiles is usually sufficient to make the sill corner weather-tight but, in some cases, a quadrant may be required to prevent water penetration where the lead upstand passes behind the tiles. The photograph shows a typical finished corner using a modern plastic replacement window with a quadrant.

Where the window is set back from the tile or slate line, it will be necessary to fit a jamb flashing to prevent water from penetrating behind the corner upstand. Fig 134a shows sill and jamb flashings in position over slate hanging and Fig 134b shows the finished detail. Note that the lap between sill and jamb flashings is positioned above the top of the window sill. Free thermal movement could be impeded if the lap is wedged behind the end of the sill.

Sill and jamb flashings should not exceed 1.5m in length. However, due to the restriction of free movement down the side with the jamb flashings behind the frame, and also the risk of nailing on the other side when the slates are fitted, a length of 1m is recommended for jamb flashings that receive long periods of direct sunlight. Laps between pieces of sill flashing should be 100-150mm (depending on the exposure) and laps between jamb flashings not less than 75mm. The apron extends 150mm down the face of the tile or slate.



Fig 134. Sill and jamb flashings in slate hanging



Flashings to tile and slate hanging (cont.)



The photographs show variations in apron edge patterns. In some cases, the flashing is cut to suit feature tiles; in others, the pattern is just the particular choice of the architect or house owner. It is important to remember, however, that with all patterns the design must suit the spacing of the joints in the tiles so that the cover at the joints is sufficient to ensure weather-tightness (Fig 135).

In normal exposures, the provision of clips to secure the edge against wind uplift is not usually necessary, but in more exposed situations, these will be required especially on the laps between pieces of flashing.

Fig 135. Apron edge patterns

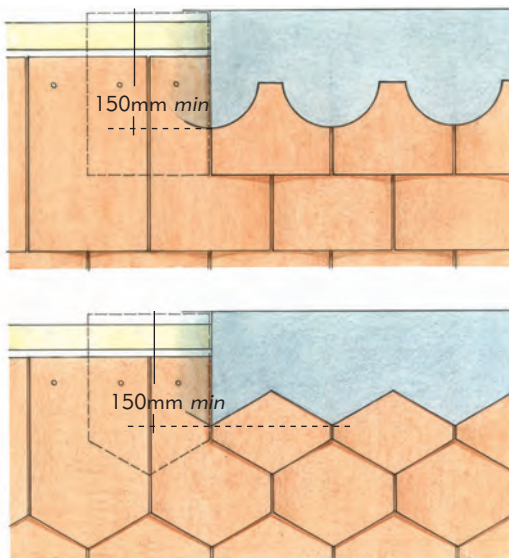
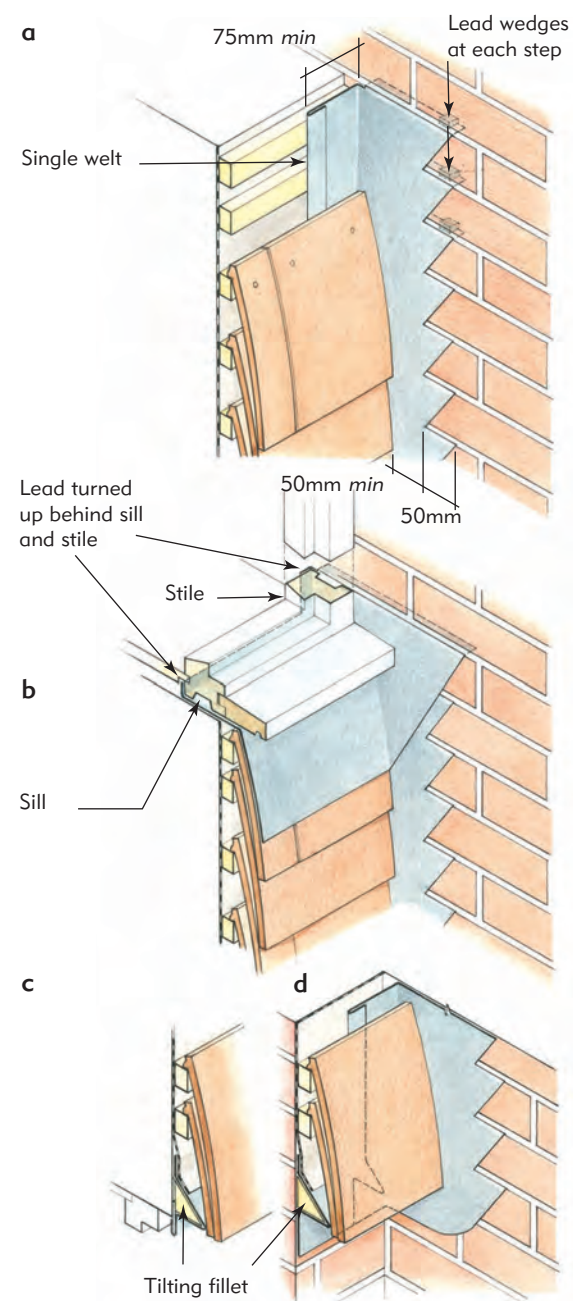


Fig 136a shows the flashing at an abutment of tile hanging to brickwork. The step flashing is usually taken behind the tiles by not less than 75mm and finished with a single welt as a weather check. With slates, the edge is not welted and therefore the lead should extend to not less than 100mm.

The sill flashing (Fig 136b) is turned up not less than 75mm and the edge wedged into the brickwork above the step flashing and then pointed.

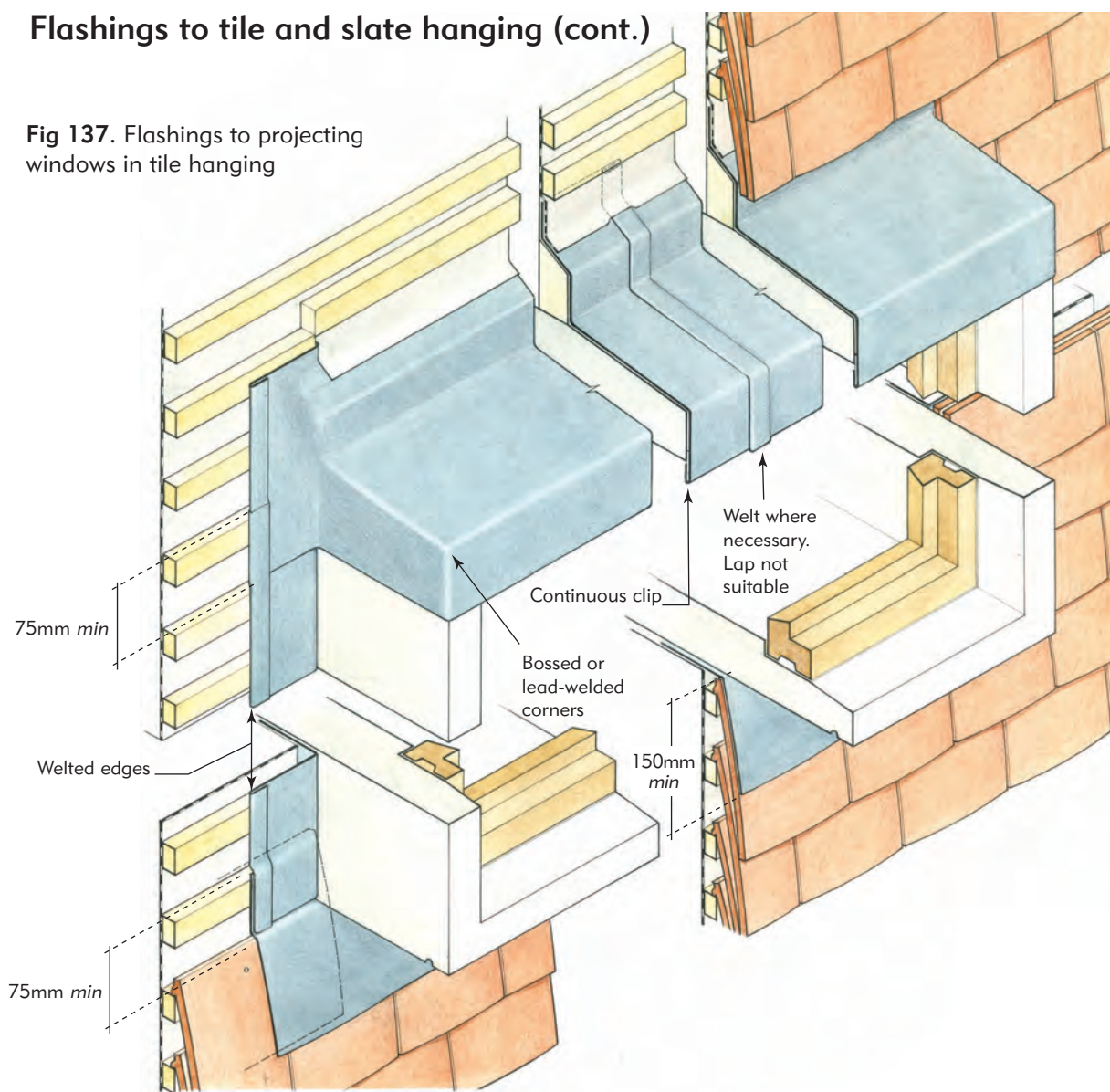
The finish at the bottom will depend on the construction. Fig 136c shows a typical detail over the head of a window and Fig 136d illustrates an example where the tile or slate hanging finishes over a brick wall.

Fig 136. Abutment and sill apron flashing in tile hanging



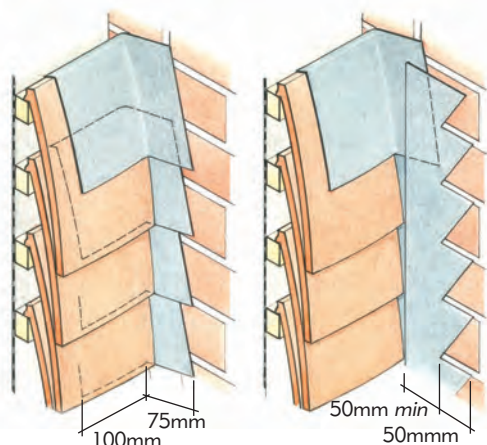
Flashings to tile and slate hanging (cont.)

Fig 137. Flashings to projecting windows in tile hanging



An alternative detail at the abutment is to use soakers with a separate step flashing (Fig 138). The soakers are set out as shown in Fig 67 (page 40) and each is held in position by turning the lead 25mm over the top of the tiles. Code 3 lead sheet is a suitable thickness for soakers, while the step flashings must be not less than code 4. Typical flashings to windows in tile or slate hanging where

Fig 138. Abutment flashing incorporating soakers



the frame projects beyond the face are shown in Fig 137. The sill flashing, which is fixed first, will be as already described, with the corners formed using lead-welded gussets. If the width of the window is more than 1.3m, it will be necessary to introduce a lap (100mm minimum) so that sill flashing lengths do not exceed 1.5m.

The jamb flashings, which should also be restricted to 1.5m lengths with 75mm vertical laps where necessary, extend 100mm along the battens and are fixed either into a groove in the side of the frame or to the battens. At the bottom of the frame, the flashings overlap the sill flashing as shown.

The top covering, which is fixed last, can be either bossed to shape at the corners or cut and lead-welded. It is fixed at about 150mm centres to the batten at the back, with the front and sides turned down and finished with a single-welted drip edge. If the overall length of the top covering exceeds 1.5m when using code 4, or 2m when using code 5, a welt should be used as shown to allow for thermal movement. Due to the risk of water penetration, laps are not suitable for end-to-end joints in this position.

Flashings to asphalt and bituminous-felt roof coverings

Fig 139a. Flashings between tiled mansard and bituminous-felt roof

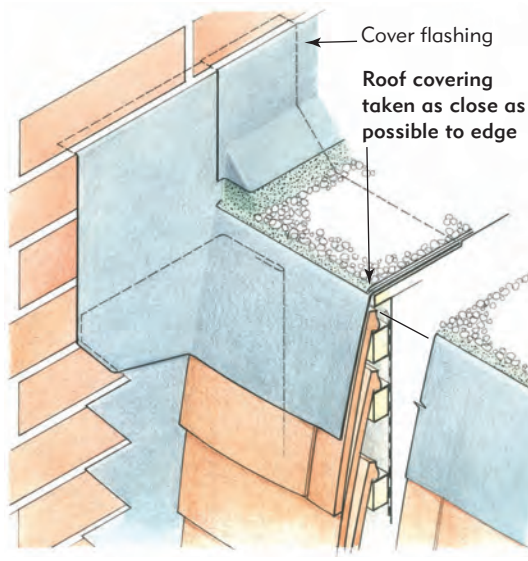
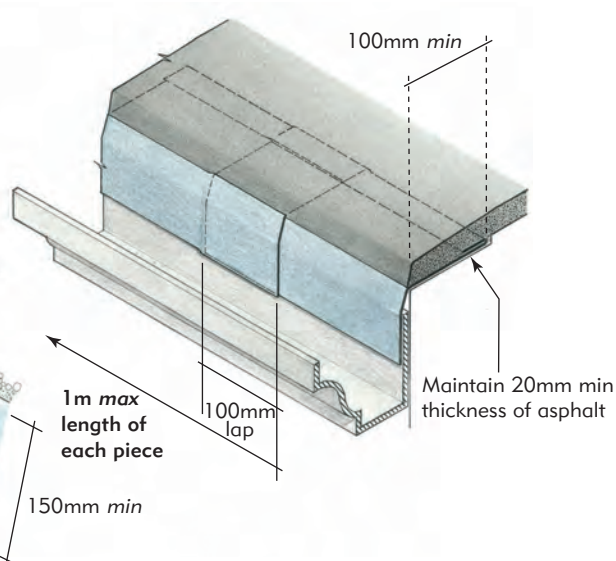


Fig 139b. Flashings between asphalt roof and eaves gutter



The ability of lead to be bossed or cut and then lead-welded to form complicated shapes makes it an ideal material to use in conjunction with asphalt and bituminous-felt roof coverings. Lead sheet is also widely used to weather the junction between an asphalt or felt roof covering and a tiled or slated roof, and also as a finish over an eaves gutter (Fig 139). Details for each type of roofing material should be checked with the manufacturer as new products may require different treatment.

As flashings to asphalt and bituminous felt are usually bonded continuously along one side of the roof covering, **it is essential to limit the length of pieces to 1m** so that the thermal movement of the lead will not cause distortion when exposed to long periods of summer sun. Joints between flashing pieces should be laps (100mm minimum) and it is important that the roof covering should finish as **close to the edge as practical** to avoid the risk of water penetration through the flat section of the laps.

To provide a key for the asphalt, the edge of the lead is usually turned to form an open welt but this is not required with felt roofs since the very hot bitumen coating provides good adhesion between the felt and the lead. With both asphalt and bituminous felt, the cover over the lead must not be less than 100mm.

On dormers, flat-roof extensions and so on that are to be covered with asphalt or bituminous felt, lead sheet is used to provide a weathering at the vulnerable corners. Typical examples are shown in Figs 140 and 141. The size of the flashings will depend on the choice of tiles used for the pitched roof, but for general guidance 100-150mm is allowed for bonding into the flat roof covering, 200mm up the roof slope under the tiles and 150-200mm for the extension at the side.

Fig 140. Flashings to corner of a flat roof extension

With single-lap tiles
Felt omitted for clarity

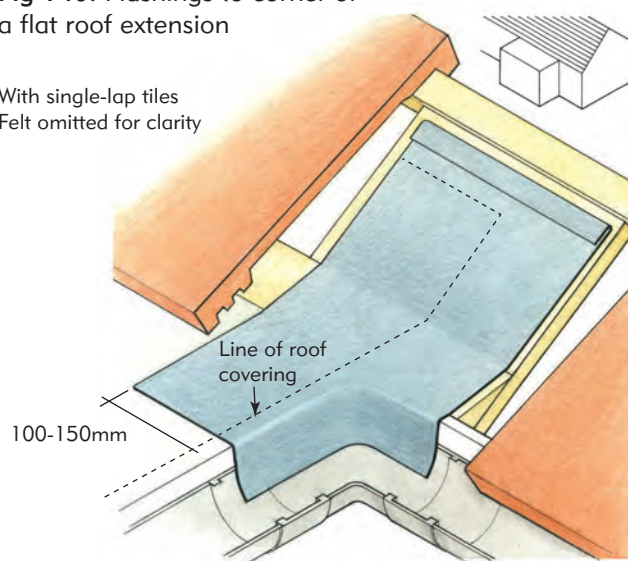
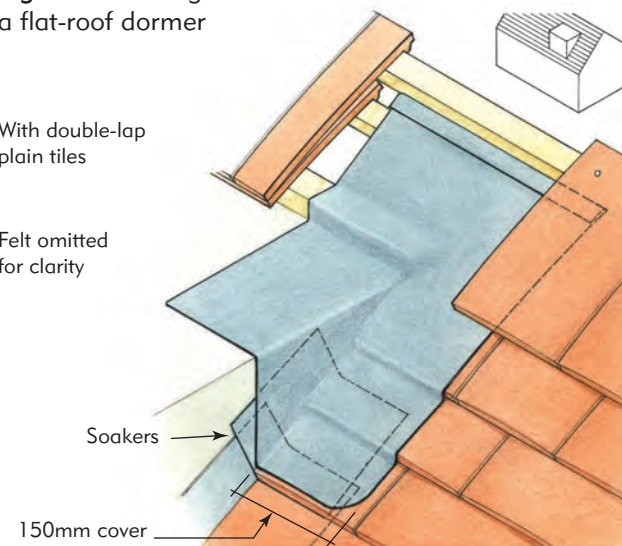


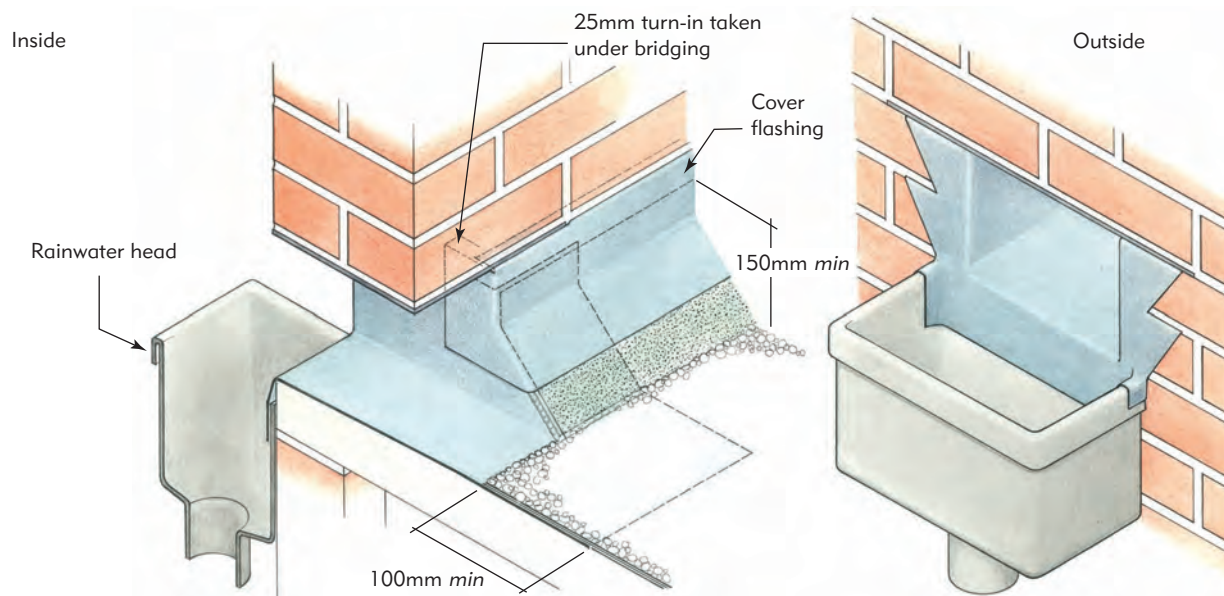
Fig 141. Flashings to corner of a flat-roof dormer

With double-lap plain tiles
Felt omitted for clarity



Flashings to asphalt and bituminous-felt roof coverings (cont.)

Fig 142. Chute outlet to bituminous-felt roof



Lead sheet is used to form chute outlets from behind parapet walls. The flashing, which is bonded into the roof covering as previously described, collects the rainwater and discharges it through the wall and into a rainwater head. A typical detail is shown in Fig 142.

Occasionally lead sheet is used where an outlet from a flat roof discharges into an internal rainwater pipe. The outlet can be fabricated by bending a piece of lead sheet to form a pipe and lead-welding to a flange, as shown in Fig 143a. A similar flashing can be used where a pipe or other projection penetrates through a roof (Fig 143b).

Fig 143a. Flashing to outlet through asphalt roof

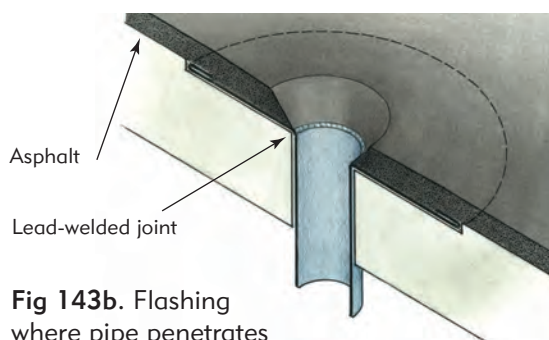
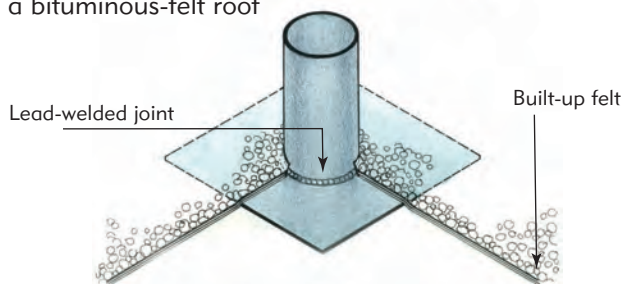


Fig 143b. Flashing where pipe penetrates a bituminous-felt roof



Flashings to roof lights, patent glazing and access hatches

Lead sheet is an ideal flashing material where patent glazing abuts a brick or other vertical surface. If the glazing bars are not deeply profiled, code 4 lead sheet can, with care, be dressed to lie close to the surface of the glass. To prevent the glazing bars from cutting into the lead and to avoid breaking the glass, it is recommended that a piece of cloth or other soft material is laid under the lead during dressing (Fig 144). The cloth can be removed once the lead is formed and the flashing then finally pressed on to the glass.

An alternative method, particularly suitable when sharp, deeply profiled glazing bars are used, is to cut and lead-weld gussets over the bars, as shown in Fig 77 (page 43).

This work can be carried out on the bench and is strongly recommended when flashings are fitted over costly double-glazed panels. Most modern skylights are supplied with attached flashings but lead sheet is often used with north lights. Fig 145 shows typical details with a roof covering of profiled sheeting.

Flashings to roof lights, patent glazing and access hatches (cont.)

Fig 144. Flashing at abutment with patent glazing

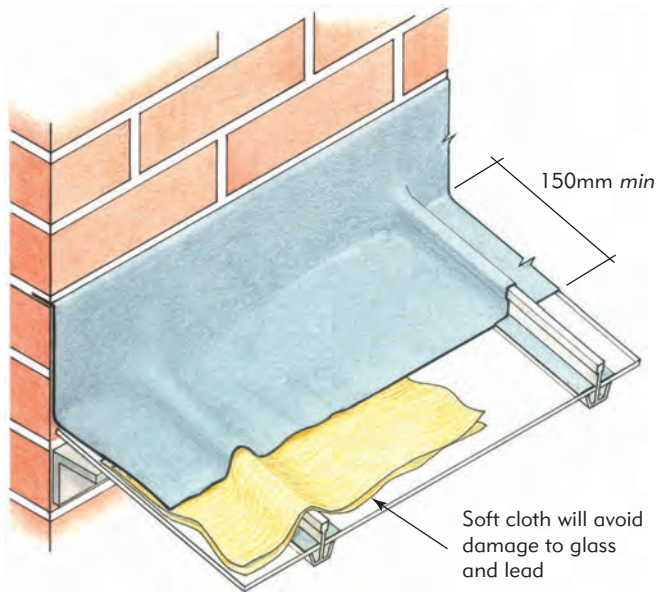
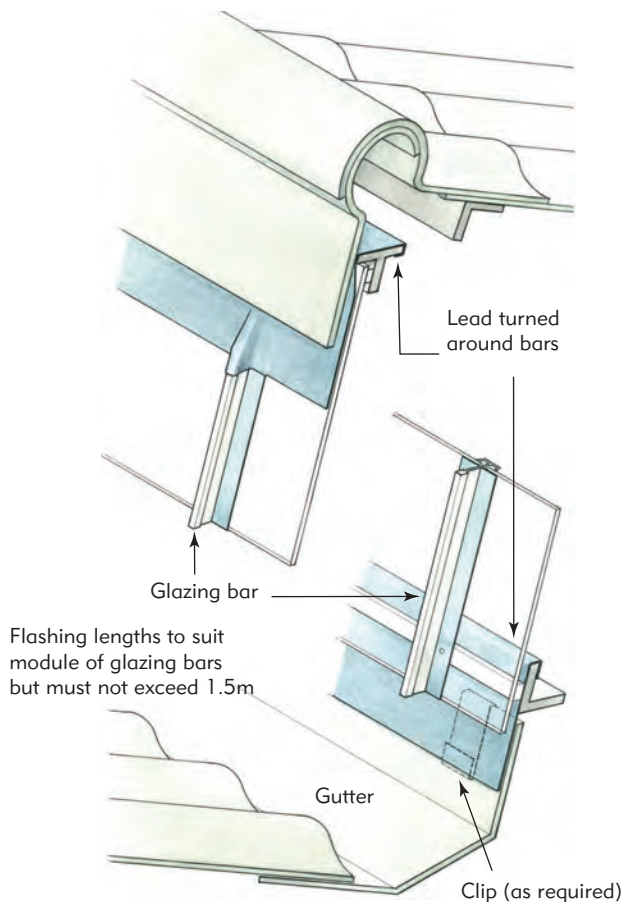
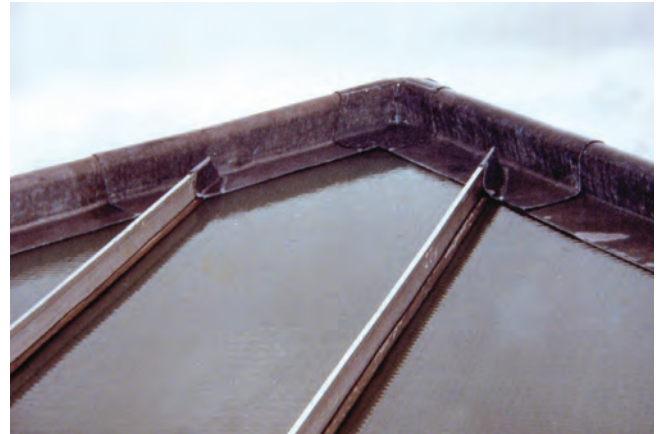


Fig 145. Flashing to proprietary north light



Due to the restriction of free thermal movement where the profiled sheeting rests on the lead, and where the glazing bars are fixed through the lead at the bottom, it is important that flashing lengths do not exceed 1.5m. However, since many glazing systems use a 600mm module, pieces of about 1.25m length with 100-150mm end-to-end lap joints spaced between every second glazing bar will be more appropriate.

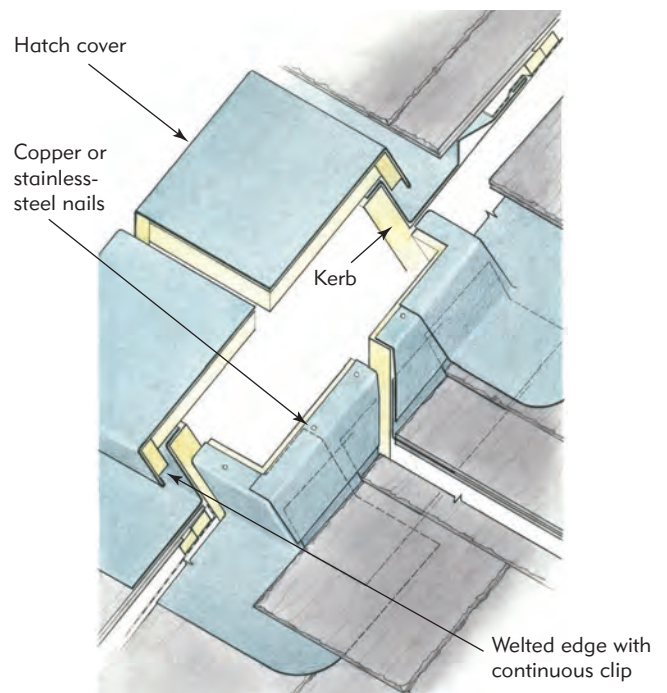


Although flashing an access hatch is similar to a chimney, the method of forming the front apron and back gutter are again shown in Fig 146. If single-lap tiles are used for the roof covering, a side cover flashing would be used, extended to cover the tiles by 150-200mm, instead of soakers as shown.

The lead covering on the hatch top is turned down on all four sides, with the bottom edges turned to engage a continuous clip. Although the weight of the top is usually sufficient to hold the hatch firmly in position, bolts are normally fitted on the inside for security reasons.

When daylight is required in the roof area, the hatch cover can be substituted by a plastic dome with the supporting bracket fixed to the inside of the timber kerb.

Fig 146. Flashing to typical access hatch (also applicable to rooflights, dome lights etc).



Flashings for roofing renewal

Renewal of the roof covering on houses and bungalows is now commonplace. When re-tiling or slating these roofs, it is important that the abutments or junctions between differing roofing materials are made permanently weather-tight. Lead sheet is the ideal material for this purpose.

Properties with projecting party walls

Recommended methods of weathering abutments and chimneys using lead sheet are described and illustrated on previous pages.

It is important to remember, however, that abutment and chimney flashings are designed to prevent rainwater from penetrating between the brickwork or masonry and the roof covering. They will not stop wind-driven rain that penetrates into a wall from seeping into the area below the roof surface. That is the function of a DPC or an impervious capping (see photo). In addition, as many roof areas are now converted into habitable rooms, any water that penetrates into the wall can bypass the 25mm turn-in of the lead flashings to cause unacceptable dampness in the living area below.

Terraced and semi-detached houses

Originally, rows of terraced or semi-detached properties were covered with one type of slate or tile. In many cases, however, adjacent roof areas are not renewed at the same time and adjoining owners will not only vary the time of renewal but also often choose differing makes and profiles of slates or tiles from those of their immediate neighbours.

Fig 148 shows the method of flashing between an existing plain-tiled roof and a new profiled tiled roof. After the existing tiling battens have been trimmed, new battens are carried past the centre line of the party wall and double-nailed to the last rafter. A 50mm x 50mm batten is located over the centre line of the wall and screwed to the new tiling battens to provide a firm base for fixing a packing batten and wood roll. The thickness of the packing batten will vary according to the type of tiles used, but it is important that the underside of the wood roll is not less than 10mm above the topmost surface of the profiled tiles, otherwise there will be insufficient weathering height.

Code 3 lead soakers are used to weather the intersection on the plain-tile side of the wood roll and the upstand of the soakers must extend at least to the top of the roll. On the profiled-tile side, code 4 cover flashings are used in pieces not exceeding 1.5m in length with each piece nailed to the wood roll at the top. Three 50mm-wide clips per length are provided to retain the cover flashing pieces in position.

Where the top of the flashing joins a ridge, a capping is fabricated by bossing or lead-welding to provide a weathering on both sides. If the flashing abuts a wall or chimney at the top, the capping piece is formed as shown in Fig 148.

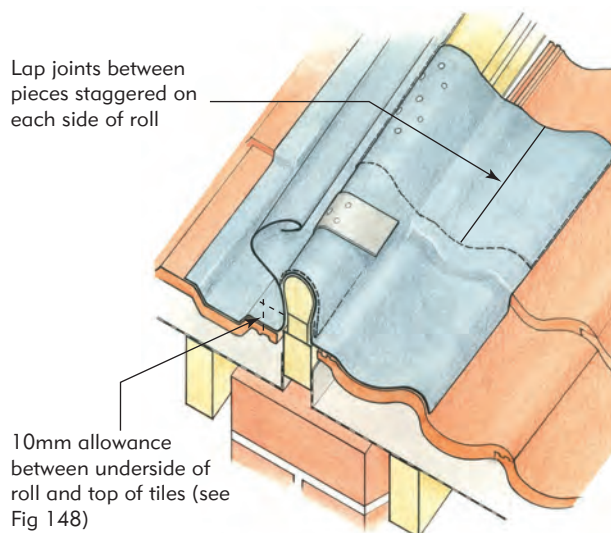


The flashing details shown for a plain-tiled roof would be similar if the existing roof covering was slate.

Fig 147 shows a method of flashing where both roofs are covered with single-lap tiles but with different profiles. This is most likely to occur when individual properties are re-roofed at different times. It would also be suitable if the existing double-lapped plain-tiled roof shown in Fig 148 were later to be renewed with single-lap tiles.

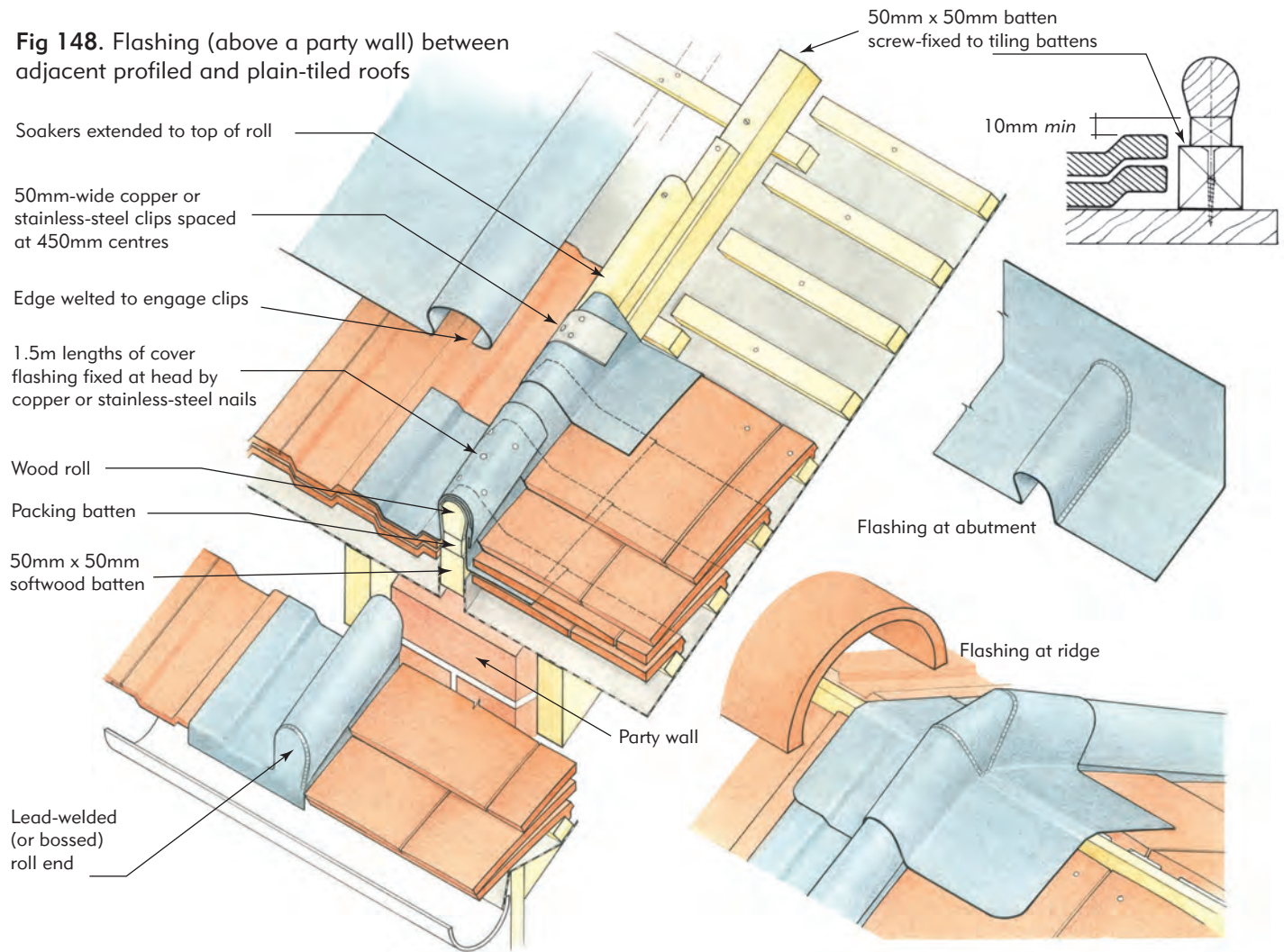
Here, the existing overcloak pieces would be lifted up to allow the 1.5m lengths of new undercloak to be fixed at the top to the wood roll with little disturbance to the neighbour's property.

Fig 147. Flashing between different tile profiles



Flashings for roofing renewal (cont.)

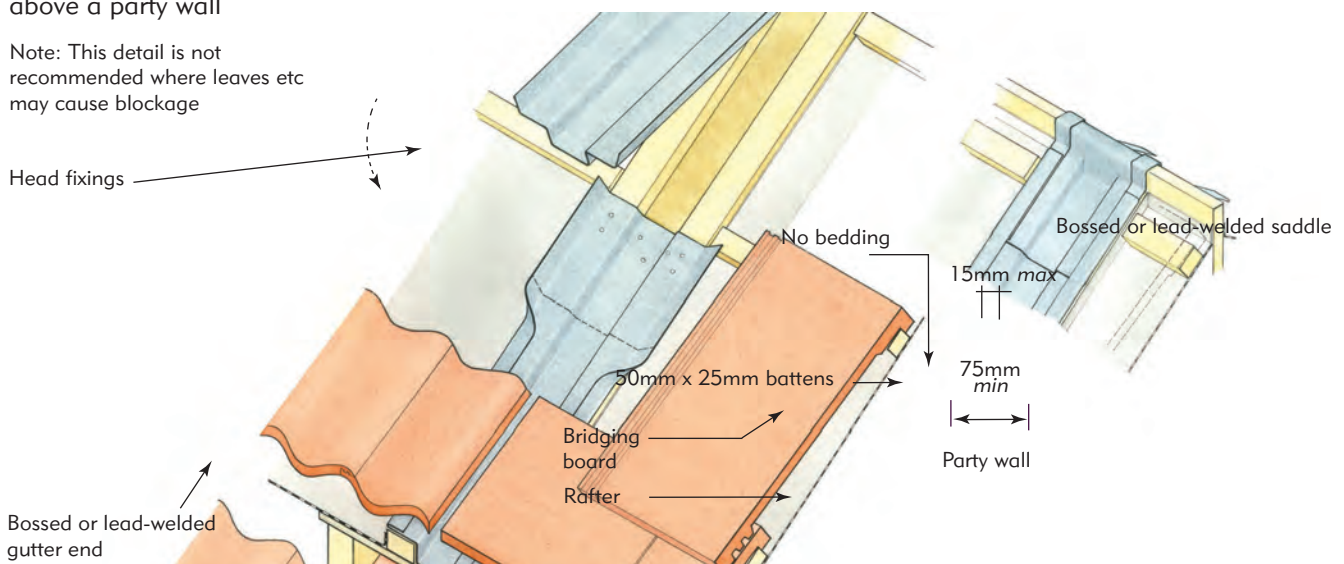
Fig 148. Flashing (above a party wall) between adjacent profiled and plain-tiled roofs



Another method of flashing between differing roofing materials and profiles is shown in Fig 149. This secret gutter detail is suitable for all types of roof covering and, by increasing the height of the gutter upstand on one side, it can accommodate variations in the surface of different roofing materials – for example, slate and deeply profiled tiles.

Fig 149. Lead-lined secret gutter above a party wall

Note: This detail is not recommended where leaves etc may cause blockage



The maximum gap between adjacent roof finishes is 15mm. This will provide a gutter width of 75mm x 25mm deep, as shown. This size should be adequate for most housing situations.

Detailing at the top and bottom of the gutter is as shown. Due to the risk of blockage, this secret gutter detail is not recommended where leaves or pine needles can fall, or be readily blown onto the roof.

Flashings for roofing renewal (cont.)

Local fire regulations may require a firebreak between existing properties. Although requirements may differ, Fig 150 illustrates a junction between an existing slated roof and a new tiled roof incorporating a practical method of complying with typical by-laws.

The firebreak comprises of galvanised mild-steel sheet not less than 1.5mm thick, folded to a 90 degree and fixed to the end rafter with galvanised nails. A series of copper or stainless steel clips not less than 100mm wide and spaced at regular intervals are fixed into the rafters over the top of this in the profile shown. Before installing the firebreak, code 3 lead soakers are fitted to the existing slates with upstands finishing to the same height as the vertical leg.

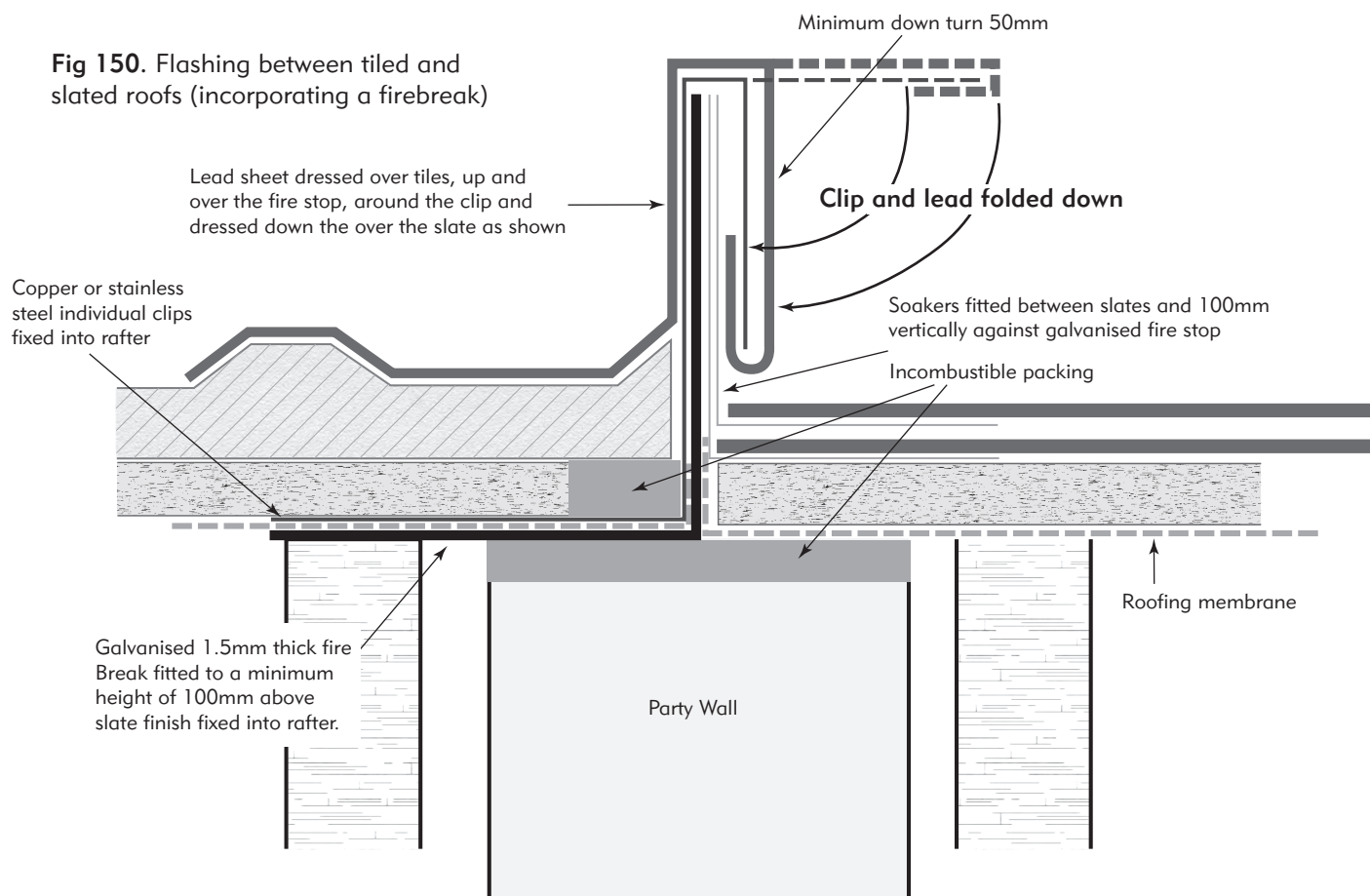
The cover flashings from the opposite side are welted around the copper clips before being turned to form a welted standing seam.

The felt and battens terminate not less than 50mm from the steel upstand, with incombustible material packed between each of the battens. Head fixing for the 1.5m lengths of cover flashing is achieved by cutting the upstand of the metal firebreak and turning a 50mm x 75mm lead tongue around the cut upstand as illustrated in the diagram below.



When re-roofing older properties, there are many alternative methods of weathering the intersections between varying types and profiles of slates and tiles. When lead sheet is used for flashings, the jointing systems shown allow for structural and thermal movement between adjacent properties without risk of water penetration. The tiles and slates on either side of the junction can be readily repaired or renewed with little disturbance to the neighbour's property and when properly detailed and fitted, the leadwork will have a life at least as long as the best tiles or slates.

Fig 150. Flashing between tiled and slated roofs (incorporating a firebreak)



Miscellaneous flashings

Butterfly junction

Weathering the junction between party walls at roof level (Fig 151a) is achieved with the use of a 'butterfly' flashing. With flat tiles and slates, the sole board can be 150mm wide, but this must be increased to 200mm for contoured tiles (Fig 151b) to allow rainwater to discharge freely at the corners. At each side, a board extends not less than 200mm up the roof slope. The depth of the board extension at the side and the position of the tilting fillets will depend on the position of the tile batten (Fig 151c). Note that a gap is left between the boards and batten to allow the tile to hook over the batten.

Fig 151a. Butterfly junctions

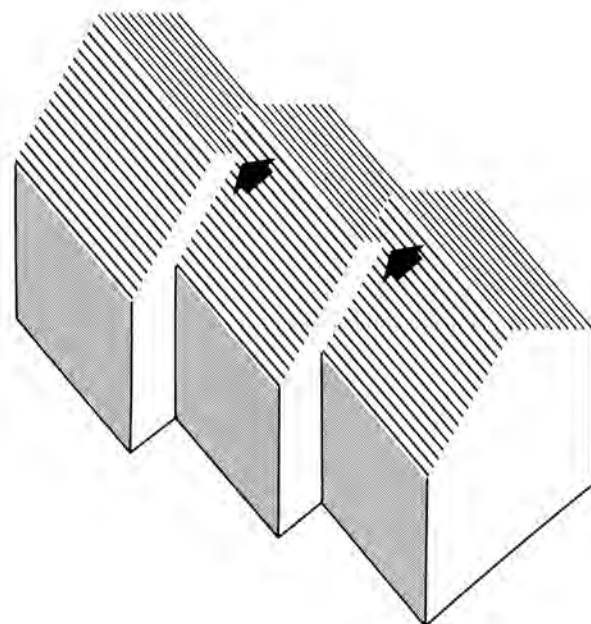


Fig 151b. Butterfly junction – section

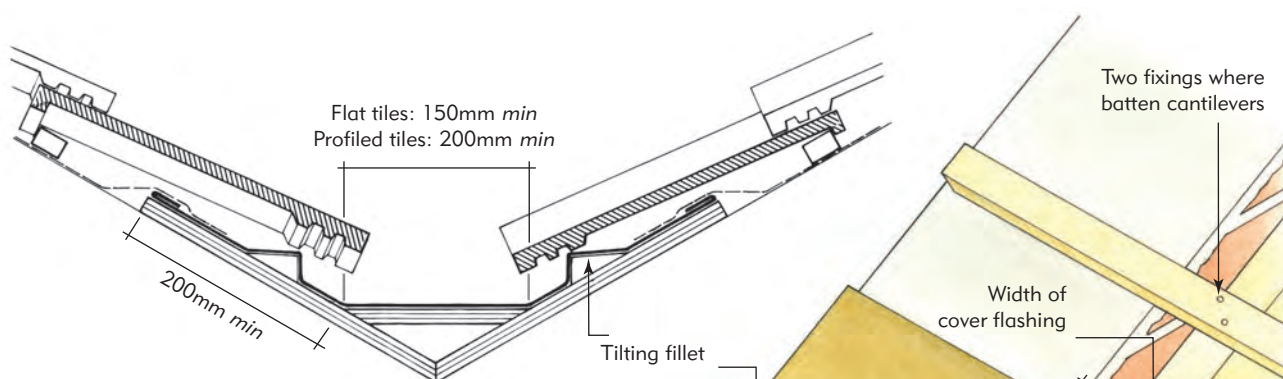
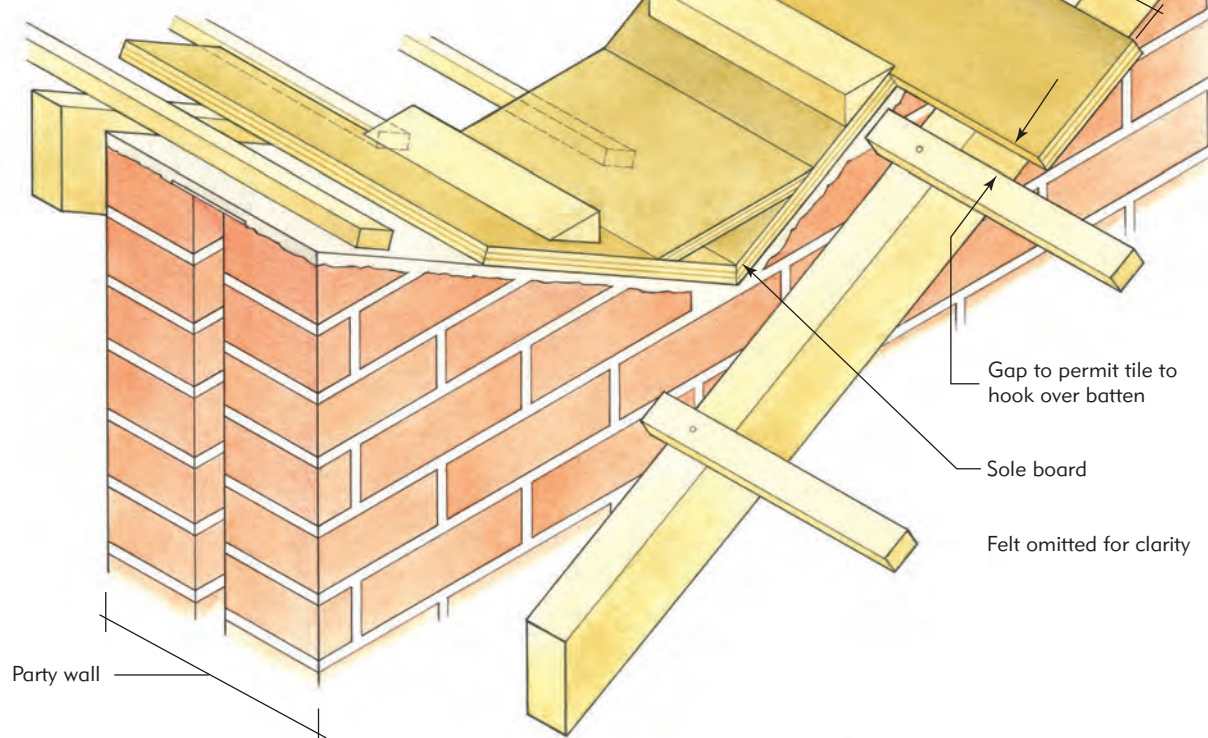


Fig 151c. Butterfly junction – substrate



Miscellaneous flashings (cont.)

A piece of lead sheet – code 4 minimum – is set out and cut as in Fig 151d and then gussets are inserted and lead-welded to form the butterfly (Fig 151e).

Fig 151f shows the flashing in position, with the corner lapping over an abutment step and cover flashing. The position of the tilting fillets will, of course, vary depending on where the first tile joint above the intersection of the party walls occurs. This will, in turn, govern the distance that the lead extends up the roof slope. The slates or tiles should be covered over on each side by not less than 150mm, increasing to 200mm for exposed conditions or where contoured single-lap tiles are used.

Fig 151d. Butterfly junction – setting-out

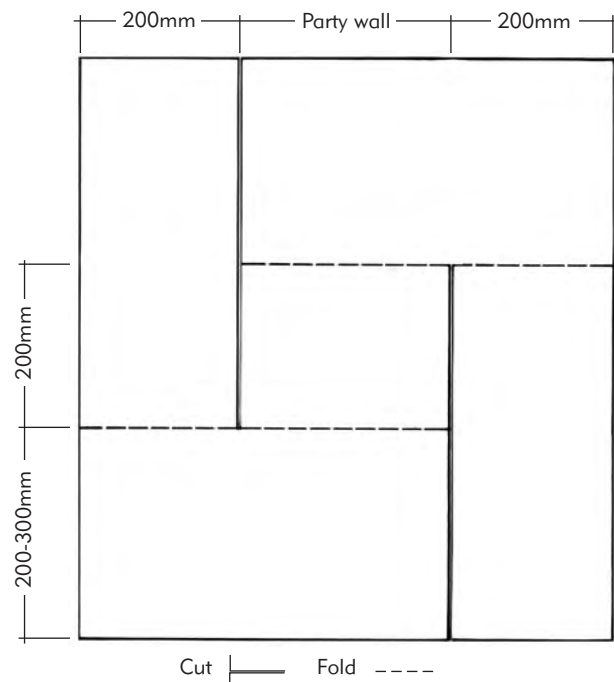
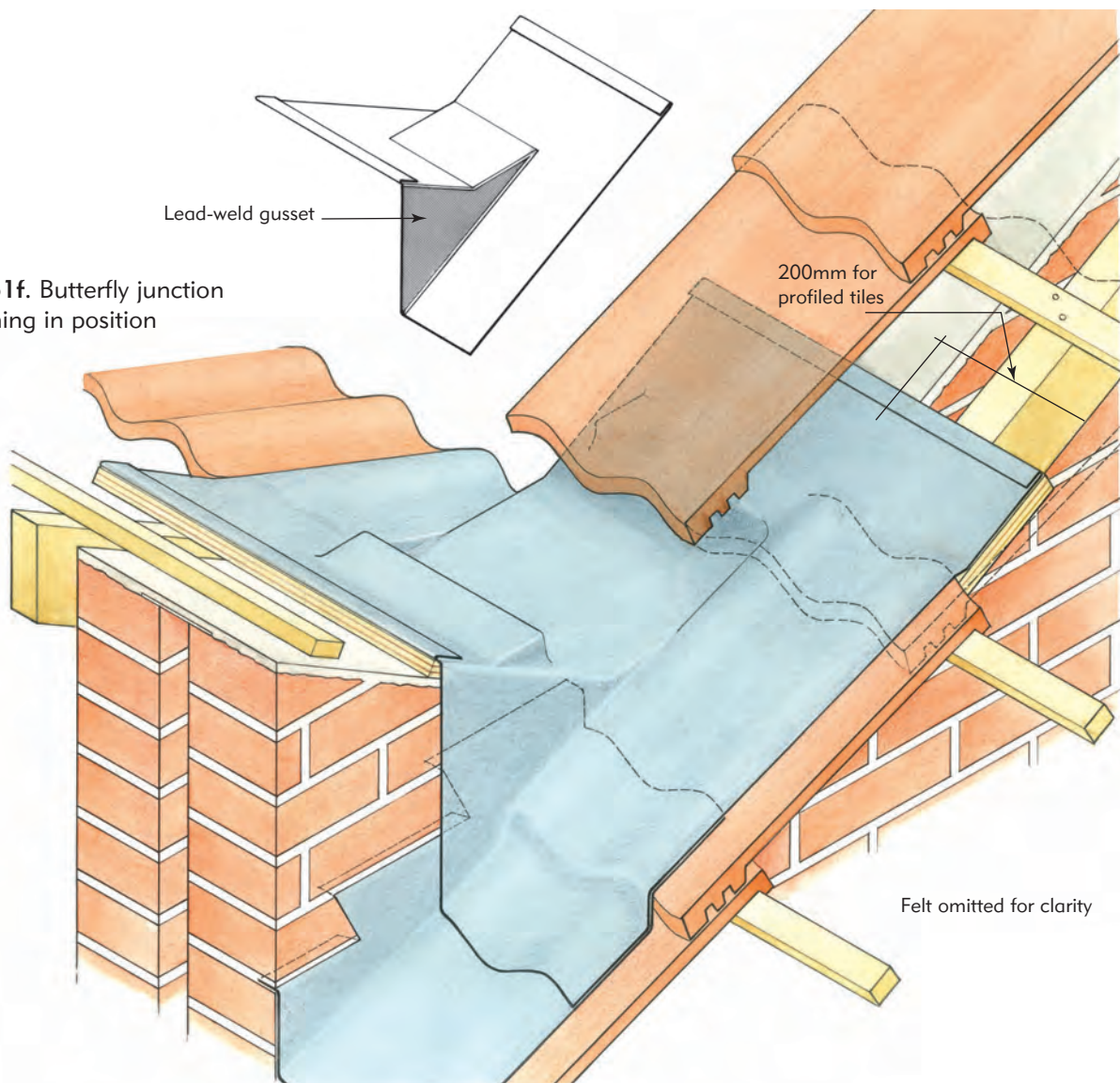


Fig 151e. Butterfly junction – preformed flashing

Fig 151f. Butterfly junction – flashing in position



Miscellaneous flashings (cont.)

Dutch or suppressed gable

The diagrams show two positions where a suppressed gable flashing will be required to make the inter-sections weather-tight. Figure 153 is an example where plain tiles are used with a bonnet hip.

The piece of lead sheet would usually be marked in position, the angles cut to suit the roof pitch and then lead-welded on the bench. On pitches below 40°, the apex of the bonnet tiles have little fall and it may be necessary to extend the gusset down the front edge of the tile to avoid the risk of water penetrating between the underside of the lead and the tile.

Fig 154 shows a similar detail where half-round tiles are used to weather the hip. Again, the lead sheet would be marked and cut in position and then welded on the bench. A separate piece of lead sheet is formed to fit over the hip tile with the top bossed or, alternatively, fabricated by lead-welding.

The practice of bedding the hip tile over the lead is not recommended because the mortar will invariably crack due to structural and thermal movement of the building. Water would then be able to penetrate through the top of the hip into the roof area below.

For both these flashings, the size of piece required will vary according to the type of hip and roof tiles used, but a cover of 150-200mm over the tiles on each side of the intersection is normally adequate.

Fig 152. Illustration of Dutch gable

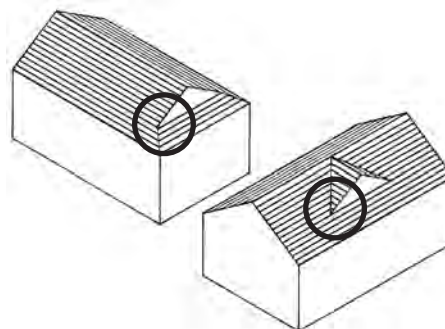


Fig 153. Dutch or suppressed gable with plain tiles and bonnet hips

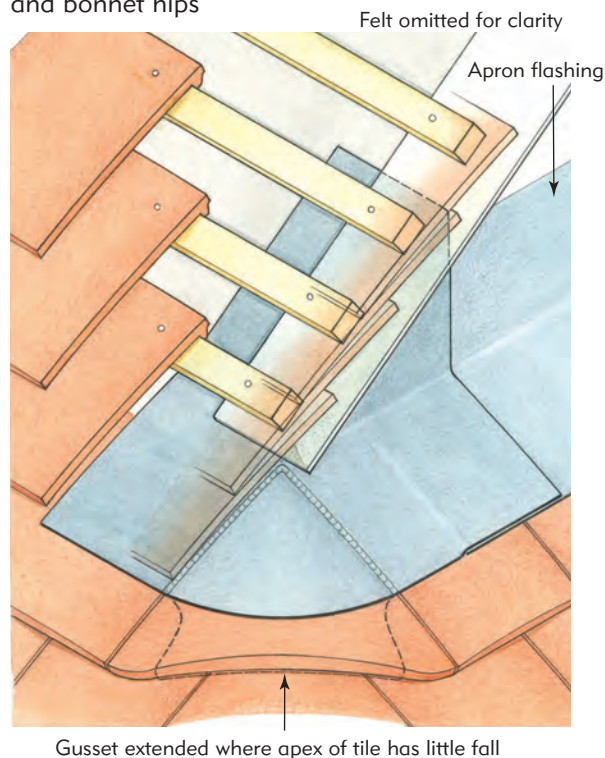
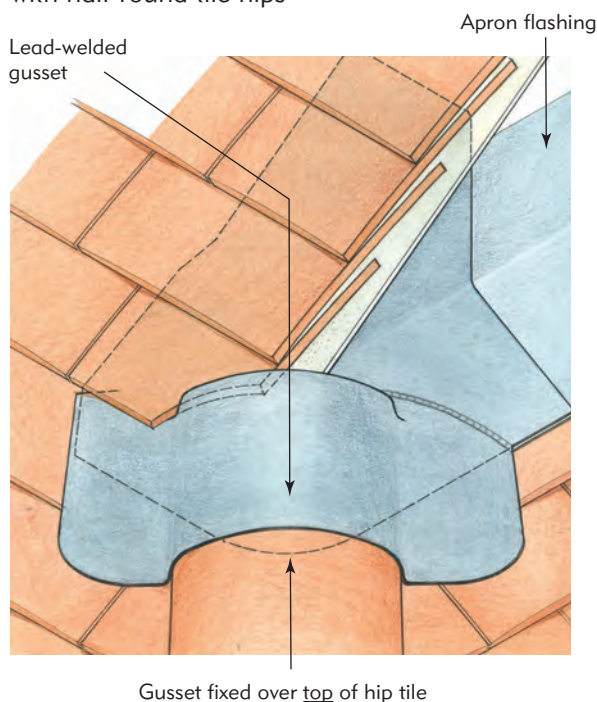


Fig 154. Dutch or suppressed gable with half-round tile hips



Miscellaneous flashings (cont.)

Dutch or suppressed gable (cont.)

Where a valley gutter terminates at the gable, the flashing is detailed as in Fig 155. After marking and cutting in position, the gusset is lead-welded on the bench. The allowance on each side of the valley is usually 250mm (see pages 58-60), and the extension up the valley should be sufficient to allow for the correct lap with the next length of gutter lining (see 'Lap joints', page 34).

There will be many variations of these details depending on the position of the gable in the roof, the type of tiles or slates used and the selection of hip tiles. However, by marking and cutting the lead sheet in position to suit the different angles, an efficient flashing can be readily fabricated by lead-welding.

Mono/pitched roof junction

Many situations arise – for example, additions to properties – where a flashing will be required. A typical example is shown in Fig 156.

The flashing can be made by simply cutting a piece of lead sheet to suit the intersection and inserting a gusset. Three examples of the same flashing are shown, but with the lead-welded gusset in a different position. All are correct provided that the lead-welding is efficient – the positioning of the gusset is the choice of the installer.

Fig 155. Intersection between Dutch gable and pitched valley gutter

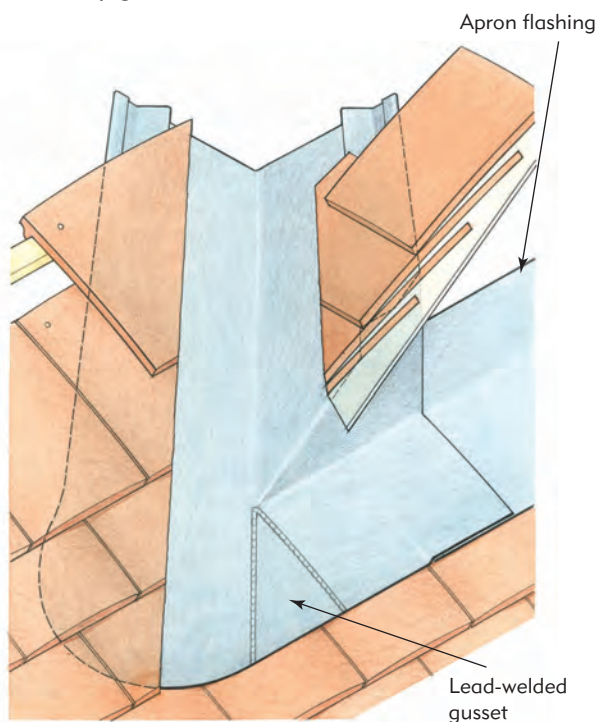
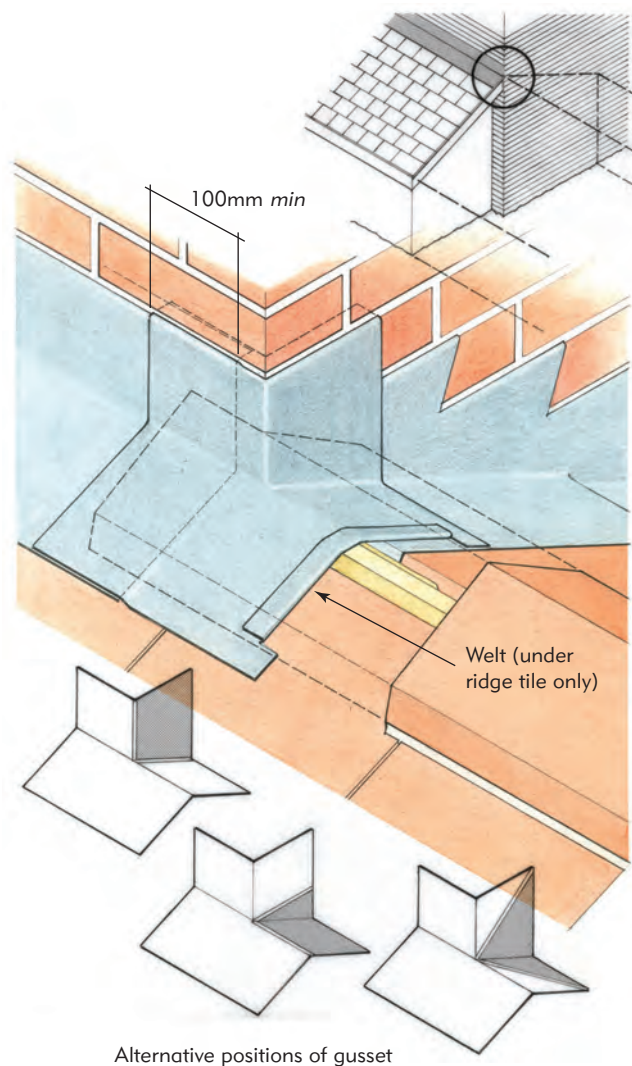


Fig 156. Flashing to mono/pitched roof junction



WEATHERINGS TO LEDGES, CORNICES AND PARAPET WALLS

Lead sheet is highly resistant to atmospheric pollution and acid rain. This makes it ideally suited to the protection of cornices and parapet walls, particularly on important and historical buildings. All projections and parapets are vulnerable to water penetration – especially through the joints in brick and stonework. Masonry that remains damp due to moisture penetration can be severely damaged by spalling when subjected to frost. Damp masonry also encourages and supports the unsightly growth of mosses and lichens. Properly detailed and fixed lead weatherings to these exposed surfaces will provide long-term protection for both old and new buildings.

The thickness of lead sheet for these weatherings will depend on the size of the individual pieces and the exposure and quality of the building. For important and historical buildings, codes 6 and 7 are generally specified, while codes 4 and 5 are normally used for other applications.

In most cases, welts are used for the end-to-end joints, although in very exposed situations where a cornice receives rainwater discharge from a vertical surface

above, it may be necessary to use rolls. For very narrow sloping projections, laps are usually suitable.

Fixings for cornice and parapet wall weatherings comprise copper or stainless-steel clips incorporated into the welted joints and along the free edges. Intermediate fixings are sometimes required, but when used, they must be positioned so that free thermal movement of the lead is not impeded. Although optional on timber surfaces, it is good practice to use an underlay when fitting lead weatherings over masonry or concrete. An underlay will prevent damage to the lead by projections or unevenness in the surface of the masonry, and will guard against underside corrosion where the lead has been laid on concrete or rendering that has not fully dried out.

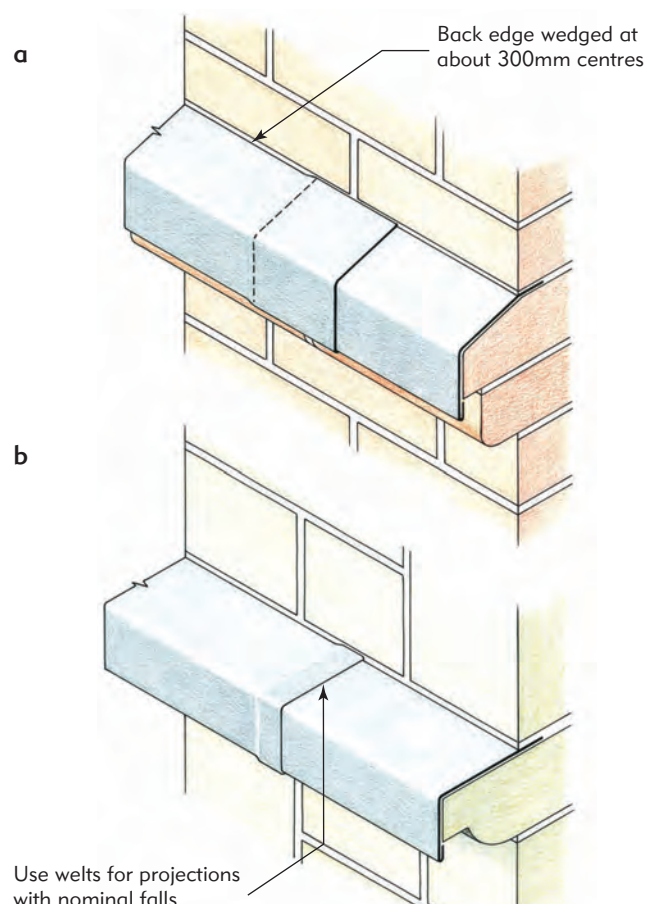
Provision of ventilation to weatherings on stone or concrete ledges, cornices and parapet walls is not usually necessary. However, if large areas of plywood or timber are used as a substrate, some ventilation may be necessary (see 'Resistance to corrosion – Condensation', pages 4-5. For ventilation details see pages 6-8).

Ledges and narrow projections

In many cases, narrow projections – for example, string courses in brickwork – slope towards the front, and laps can be used for the end-to-end joints (Fig 157a). However, where there is only nominal fall, laps would permit rainwater to penetrate due to a combination of capillary action and wind pressure, and therefore welts should be used (Fig 157b). The back of the weathering is turned into the brick or masonry joint and wedged at about 300mm centres. Code 4 is the minimum thickness to use for narrow projections, although code 5 is normally preferred for exposed positions or on quality buildings. Laps or welts should be spaced at not more than 1.5m centres, with clips positioned along the front edge to suit the exposure of the building.



Fig 157. Narrow projection



Cornices

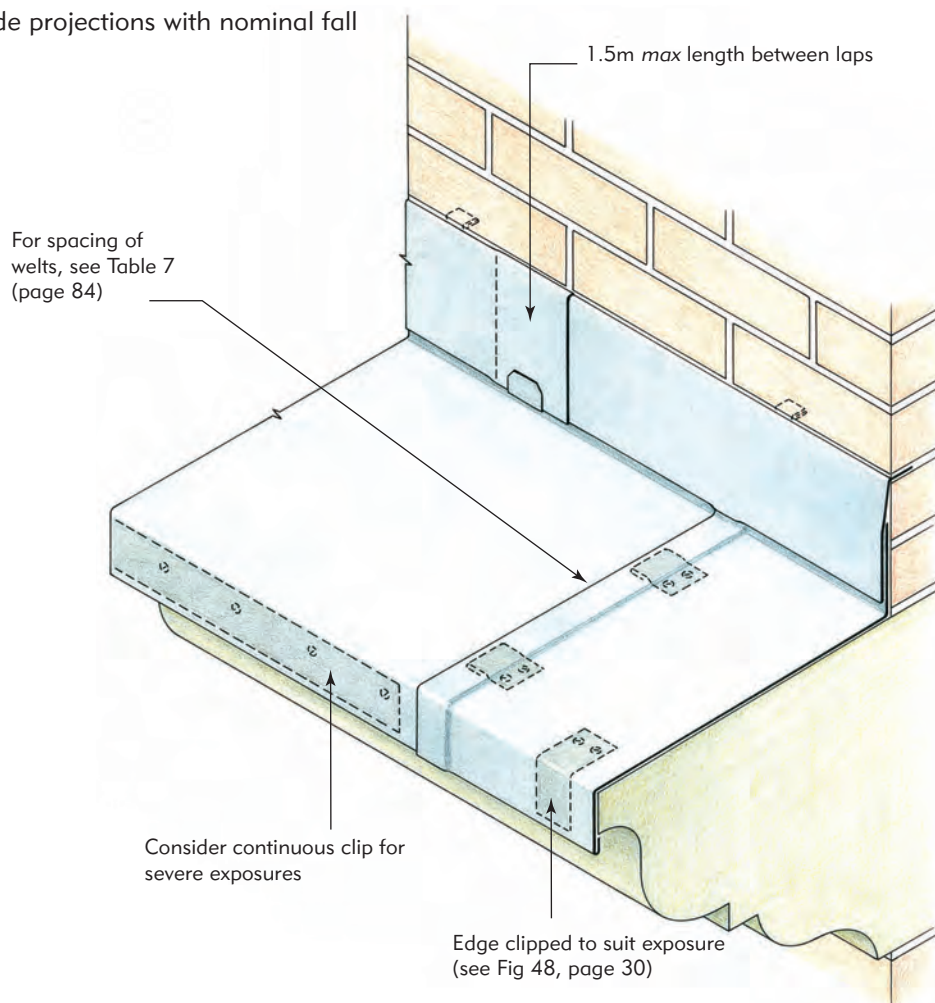
Wide projections

For projections of more than 200mm, the back of the weathering is turned up against the wall by not less than 75mm and covered with a separate flashing (Fig 158). Cover flashings should be fitted in lengths not exceeding 1.5m, with 100-150 lap joints between pieces depending on the exposure of the building.

The top edge of the flashing is turned not less than 25mm into the brick or masonry joint and wedged at about 450mm centres. Where a DPC is fitted into the wall, the flashing must be turned in under the DPC.

In most situations, welts are used for the end-to-end joints, incorporating 50mm-wide copper or stainless-steel fixing clips at 200mm-maximum centres. Spacing of the fixing clips along the front edge will depend on the exposure of the projection and the depth of the downstand (Fig 48, page 30). Where cornices have only nominal fall, the clips in the welts and along the front edge, together with the cover flashing over the upstand at the back, are sufficient to keep the weatherings in position, even in high winds. However, for sloping cornices and projections, extra fixings will be required.

Fig 158. Wide projections with nominal fall



Cornices (cont.)

Wide projections

Fig 159. Wide sloping projections – up to 10°

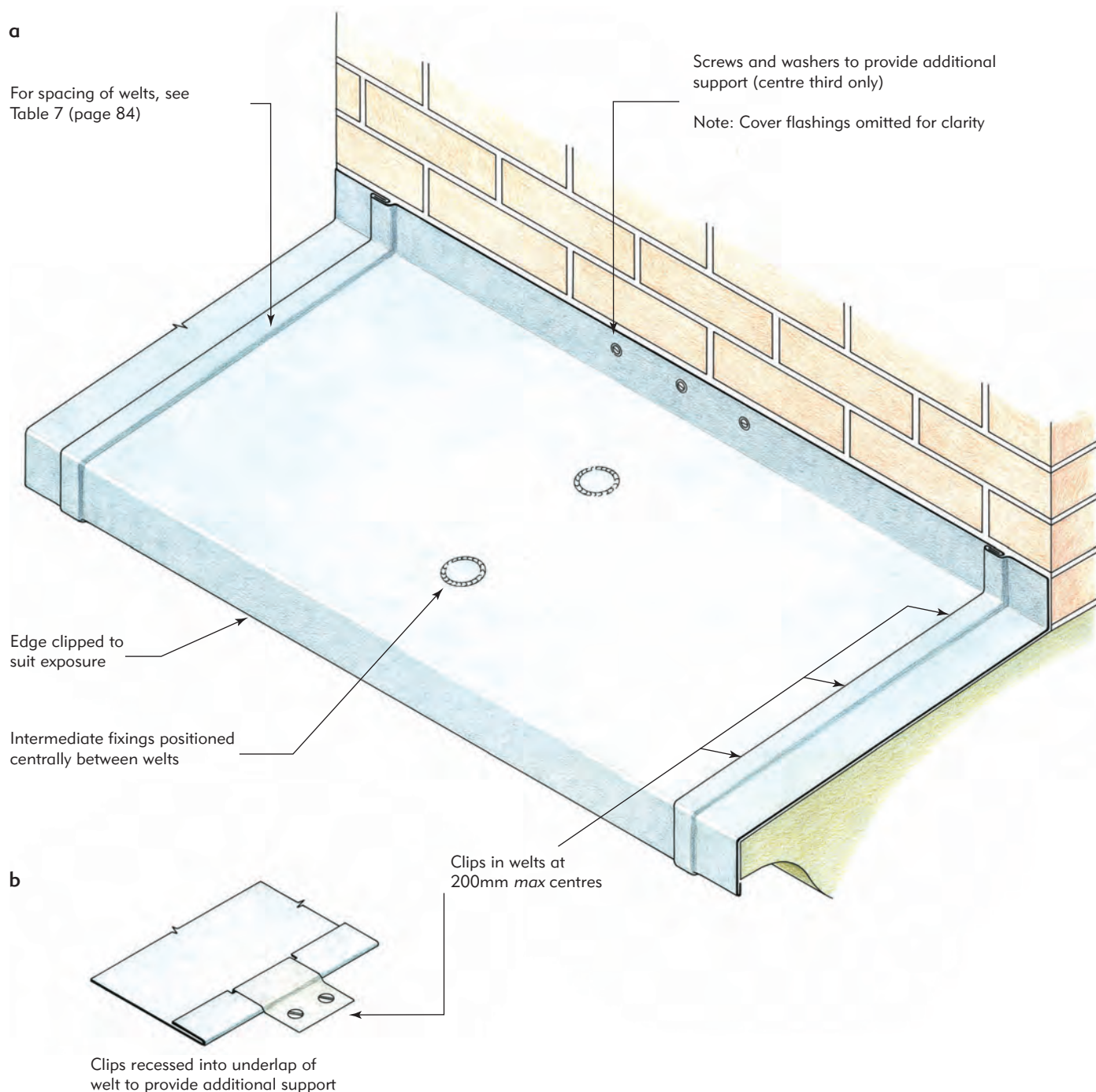


Fig 159a shows a weathering with two intermediate fixings positioned centrally between the welts. In the past, it was common practice to use several fixings along the length of each piece of weathering, but experience has shown that the fixings closest to the welts tended to restrict thermal movement of the lead.

A better method is therefore to position intermediate fixings near the centre of each piece, so that unrestricted movement can take place towards the expansion joints (welts) on each side. When covering sloping surfaces, additional fixing can be provided by screwing the upstand to the wall, as shown, and by recessing the clips into the welt undercloak (Fig 159b).

Cornices (cont.)

The number of intermediate fixings required will depend on the width and slope of the projection. Normally one fixing will be sufficient for projections up to 300mm wide and two for widths up to about 600mm. With wider projections, the welt spacing should be reduced so that the combination of intermediate fixings, clips in welts and front edges and screw fixings in the upstand are sufficient to hold the relatively small pieces of weathering permanently in position in all weather conditions.

Where the slope of a projection is more than 10°, the weatherings should be fixed at the top with one row of fixings at 50mm centres if the projection is up to 600mm wide, or two rows at 75mm centres for slopes greater than 600mm. The fixings should be sealed by lead-welding over the nail or screw heads and the flashing extended by not less than 75mm to cover these fixings (Fig 160). Intermediate fixings will not usually be required.

Table 7 is a guide to the spacing of welts but can be varied slightly to suit a particular slope or projection. It should be noted, however, that for all thicknesses of lead sheet, the smaller the piece used, the less the risk of thermal fatigue, and the easier it will be to provide adequate fixing especially on sloping surfaces.

Table 7. Recommended spacing of welts on coverings to cornices, projections and walls

BS EN 12588	Not exceeding 450mm wide	450-600 mm wide	Over 600 mm wide
-------------	--------------------------	-----------------	------------------

Nominal fall

4	1.0m	1.0m	0.5m
5	1.5m	1.5m	1.0m
6	2.0m	1.5m	1.5m
7	2.0m	2.0m	1.5m

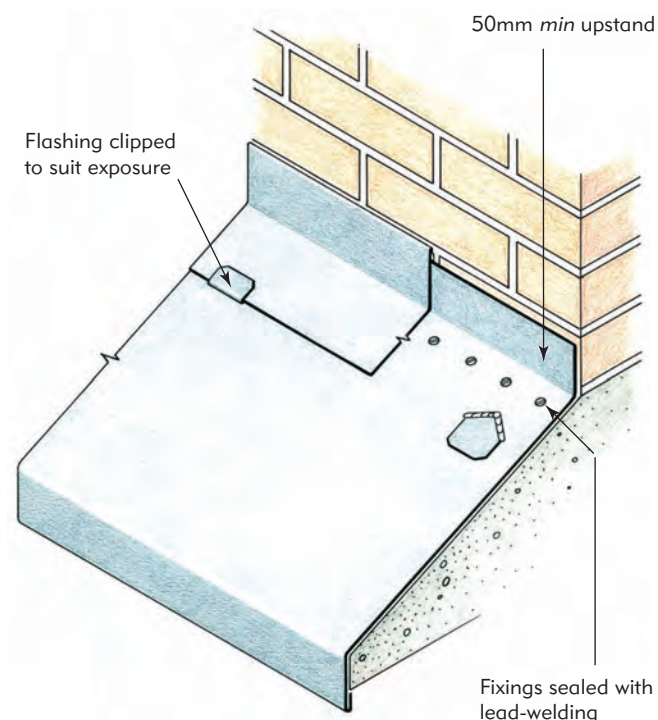
Sloping up to 10°

4	1.0m	1.0m	0.5m
5	1.5m	1.5m	1.0m
6	1.5m	1.5m	1.0m
7	1.5m	1.5m	1.5m

Sloping over 10°

4	1.0m	1.0m	0.5m
5	1.0m	1.0m	1.0m
6	1.5m	1.5m	1.0m
7	1.5m	1.5m	1.0m

Fig 160. Wide sloping projections – over 10°



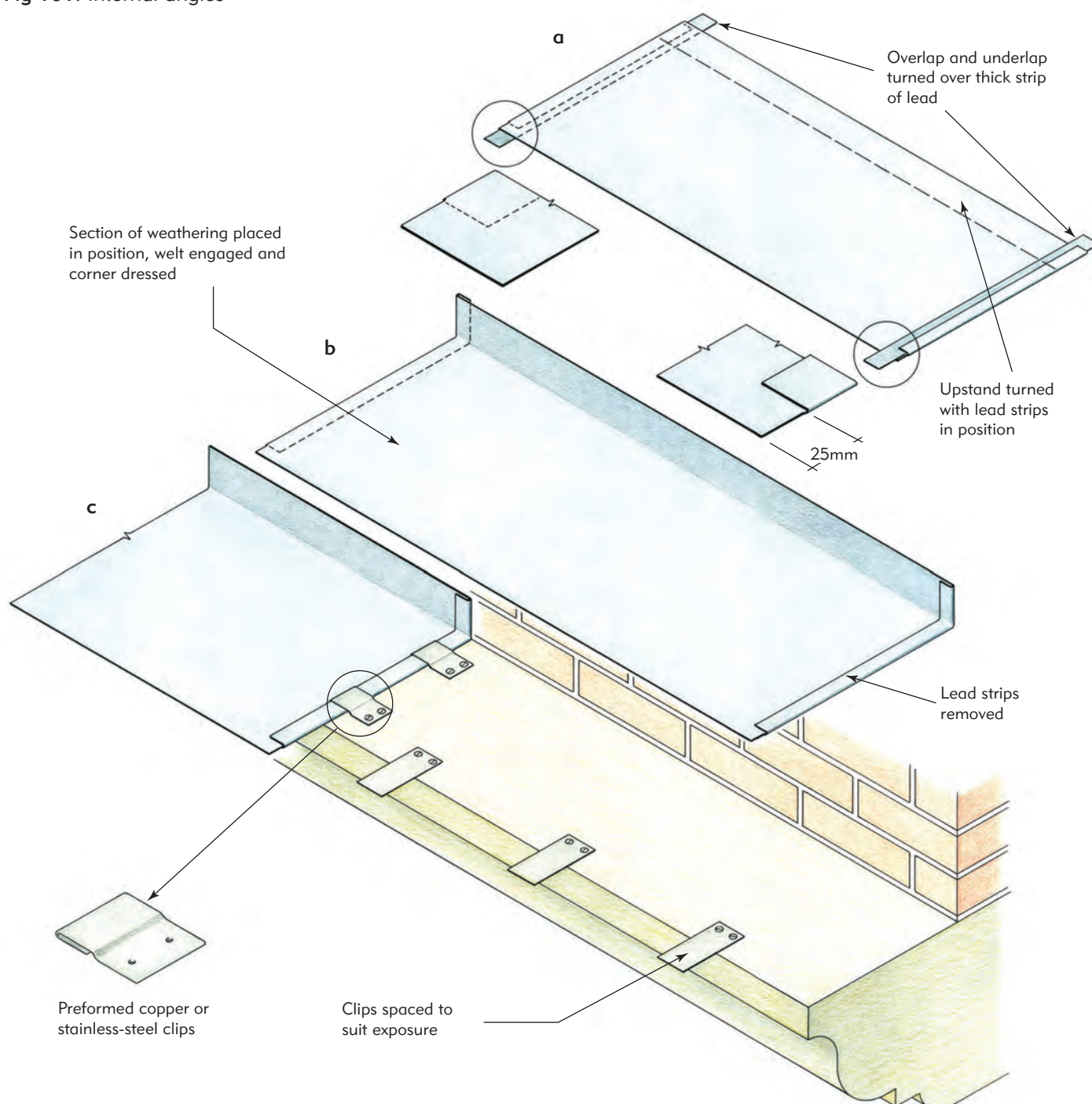
Cornices (cont.)

Internal angles

Where coverings with welted joints are applied to a deeply concave or convex surface, or turned at an internal corner, the joint is best formed as shown in Fig 161. Working on the bench, the welt underlap and overlap are turned over a strip of lead that is thicker than the covering (Fig 161a). Note the cutting away at the front corners, which is necessary to achieve a neat finish when the front edge of the weathering is subsequently turned to engage the clips.

The section of weathering is then turned to the required curve or angle before the spacer strips are removed (Fig 161b). With the previously formed section in position, clips are fixed on the underlap and along the front edge to suit the width and exposure of the projection (Fig 161c). The piece of weathering (Fig 161b) is placed in position and the welt engaged and dressed to fit neatly into the internal corner.

Fig 161. Internal angles



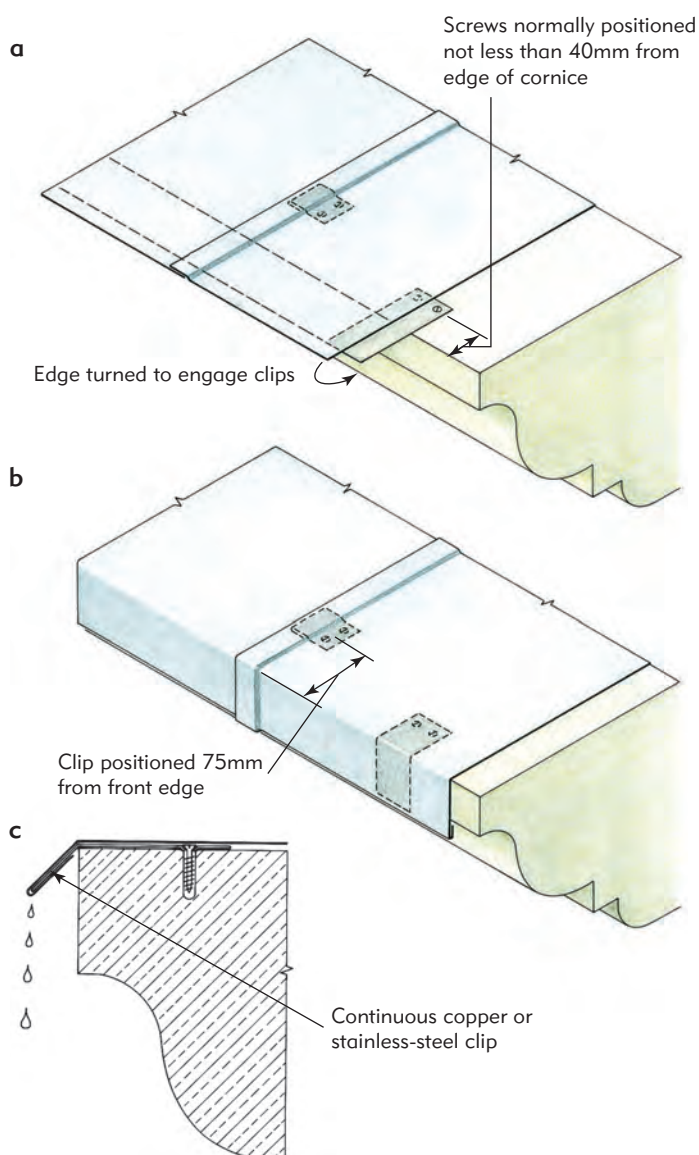
Cornices (cont.)

External angles

At the front, the edge is turned around the clips, as shown in Fig 162a, and then dressed down to finish as in Fig 162b. In exposed positions, where the clips are fixed to the front of the projection, the downstand is turned before the bottom edge of the weathering is welted to the clips.

To prevent moisture from penetrating into a cornice, the bottom of the downstand should extend below the bottom of the cornice by at least 25mm. Where, for aesthetic reasons, a deep downstand of lead is unacceptable, the edge can be finished as in Fig 162c, provided that the weathering is continuously clipped. Due to the vulnerability to wind uplift when using this detail, it will be necessary to use a thick clipping material, especially in exposed positions where the fixing point of the clip is more than 40mm from the front edge of the projection.

Fig 162. External angles



Cornices (cont.)

Corners

Although it is possible to position a welt across the diagonal of both internal and external corners, it is difficult to achieve a neat finish where the welts turn at the front and back of the projection. The more usual practice, particularly with sloping cornices, is to lead-weld the corners and position a welt on each side (Fig 163).

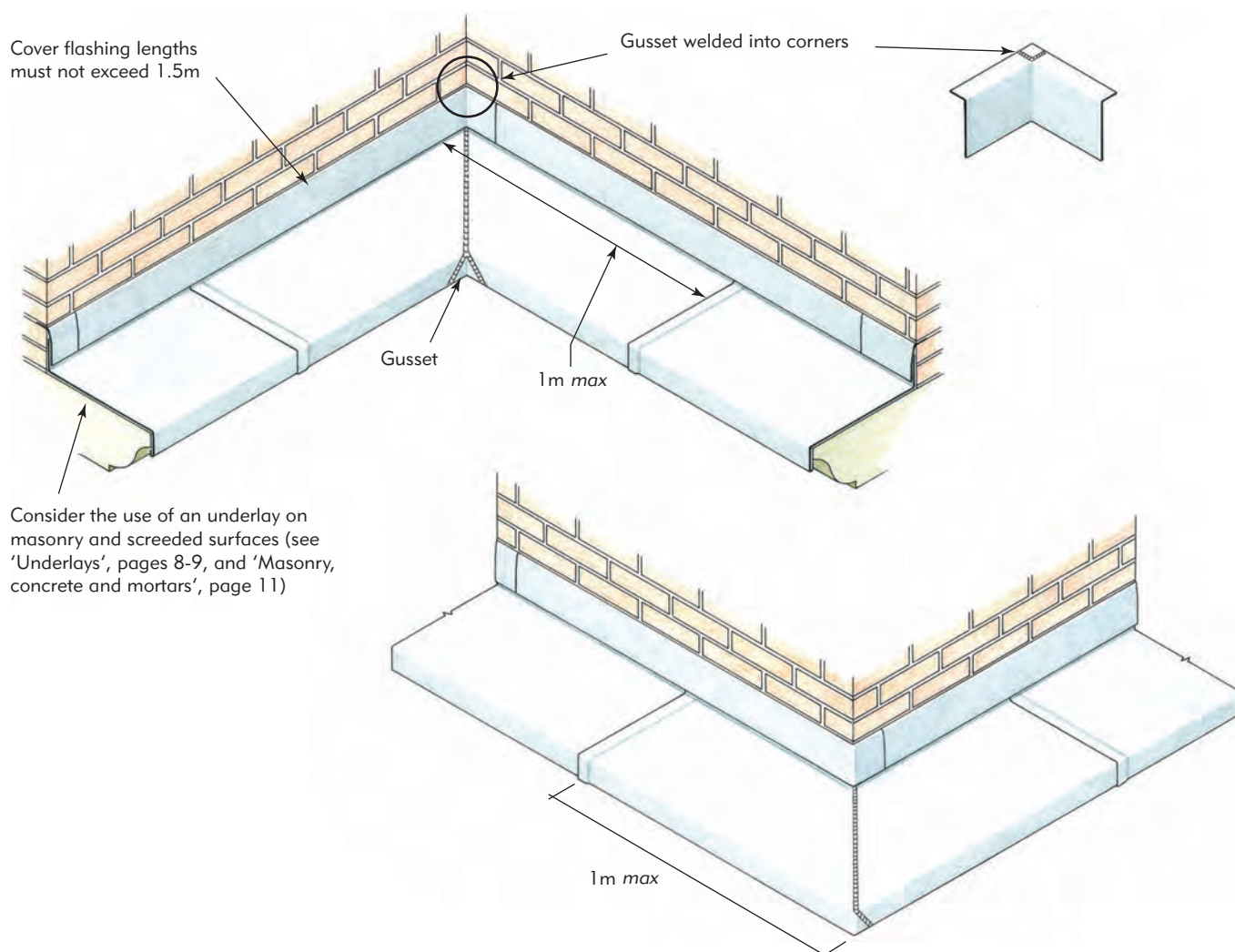
Normally the welts are not more than 1m from the corner, but this distance should be reduced when using codes 4 and 5 for wide projections.

The upstand against the wall is weathered with a cover flashing, fixed in lengths of not more than 1.5m and

clipped to suit the exposure of the building. Note the insertion of a square gusset at the corner of the turn-in to ensure a weather-tight joint at this vulnerable point.

An alternative to the welded corner for projections with shallow falls is to set out the internal and external corner pieces as shown in Figs 164a and b. For economy, the welts are normally positioned close to the corners. Figs 164c and d show the corner pieces in position prior to turning the front edges down.

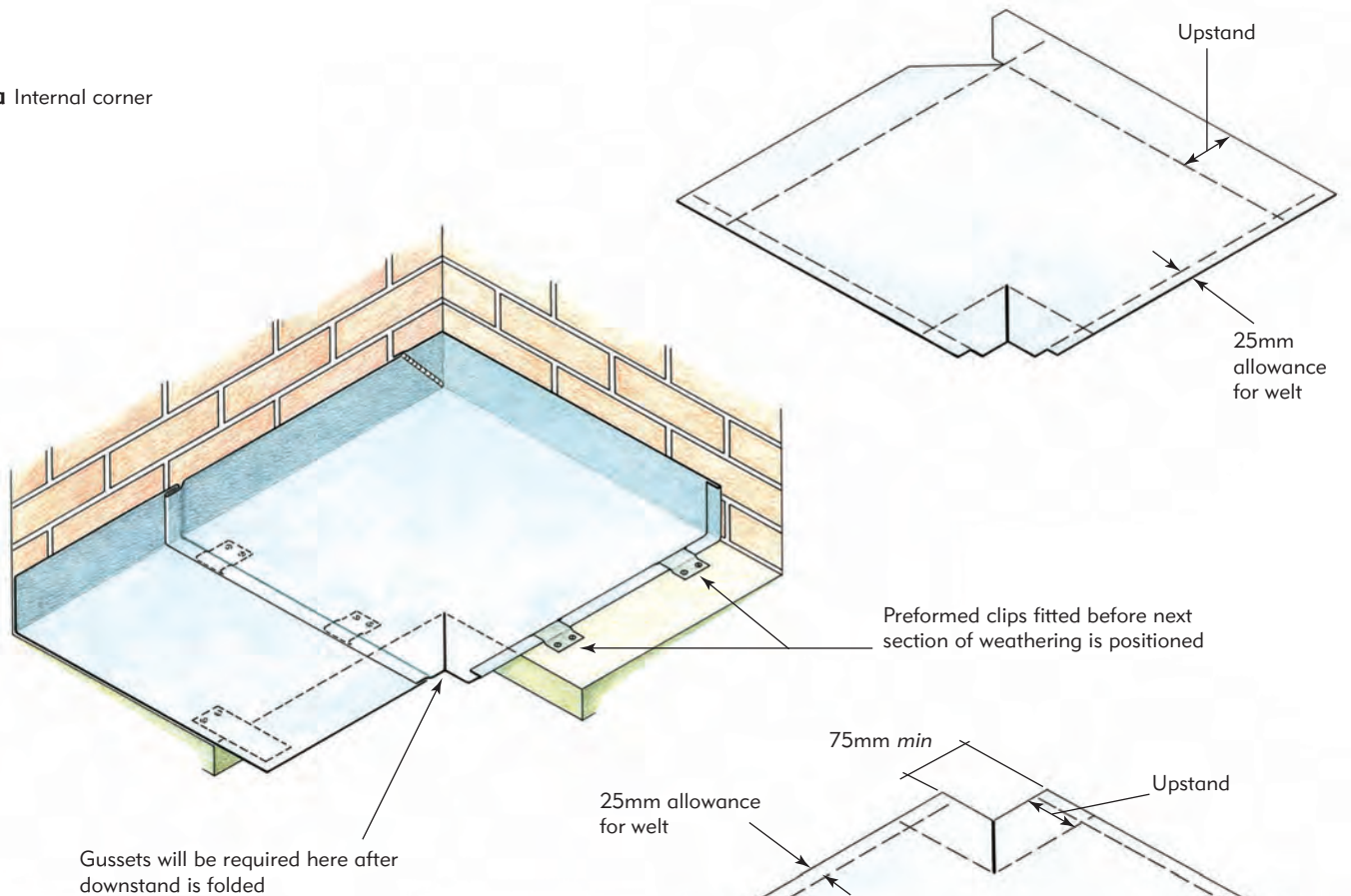
Fig 163. Corners lead-welded



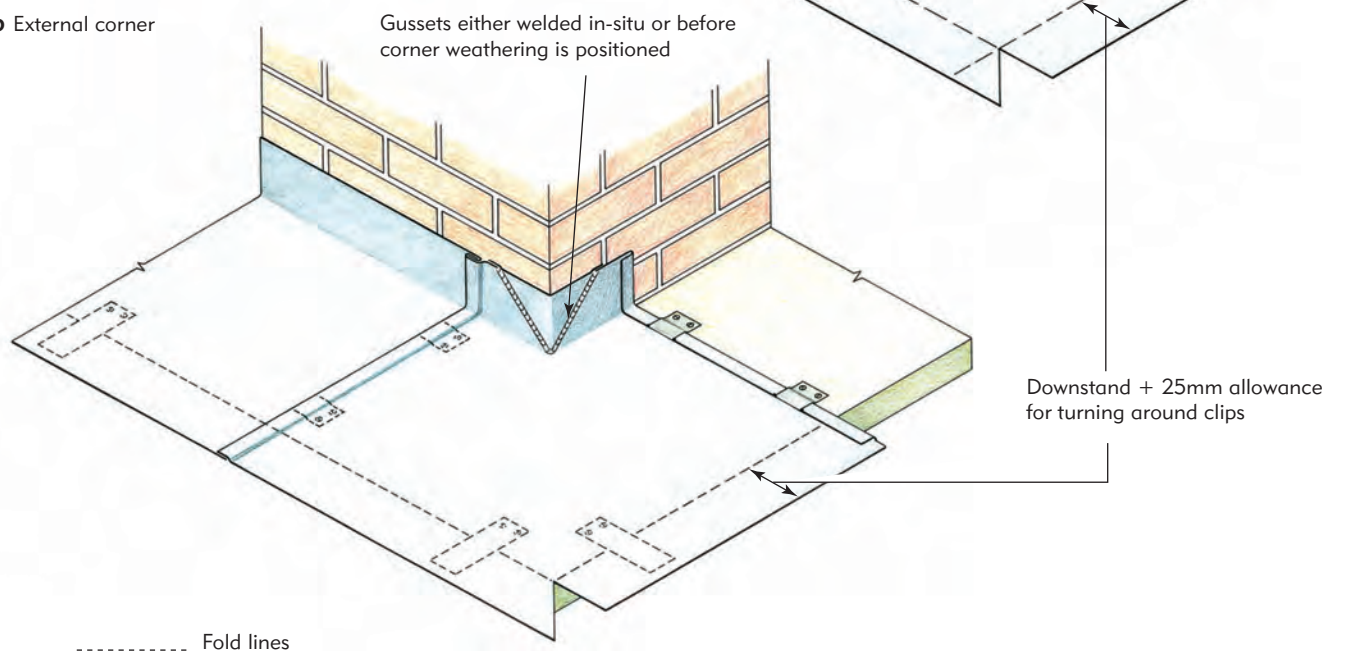
Cornices (cont.)

Fig 164. Corners – alternative details

a Internal corner



b External corner



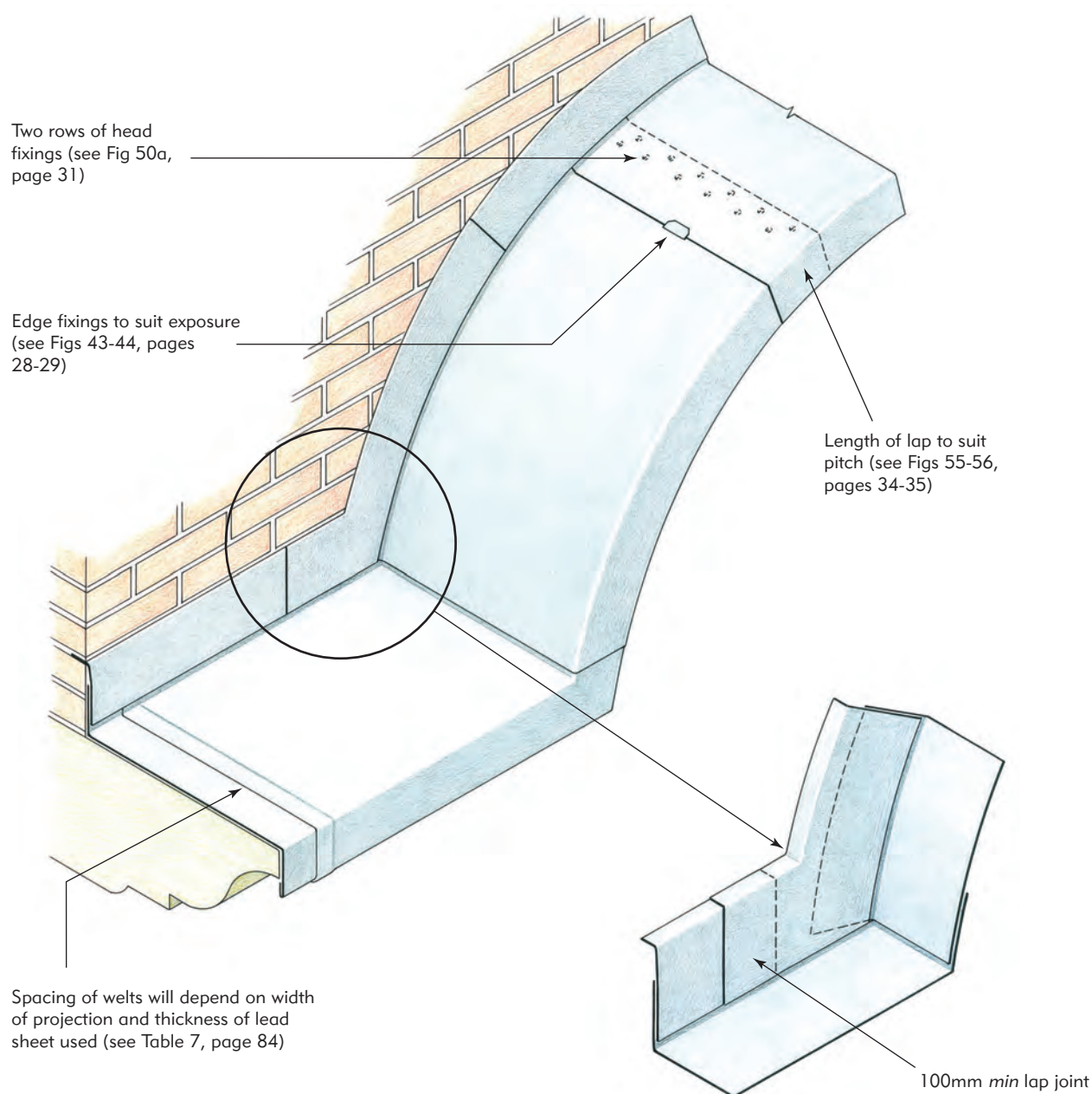
Cornices (cont.)

Pitched and curved projections

The detailing of weatherings for pitched or curved projections is similar to horizontal projections except that laps should be specified instead of welts, and head fixings are required to hold the individual pieces of lead sheet securely in position (Fig 165). However, where the pitch is 10° or less, laps will not normally be suitable and welts incorporating fixing clips should be used.

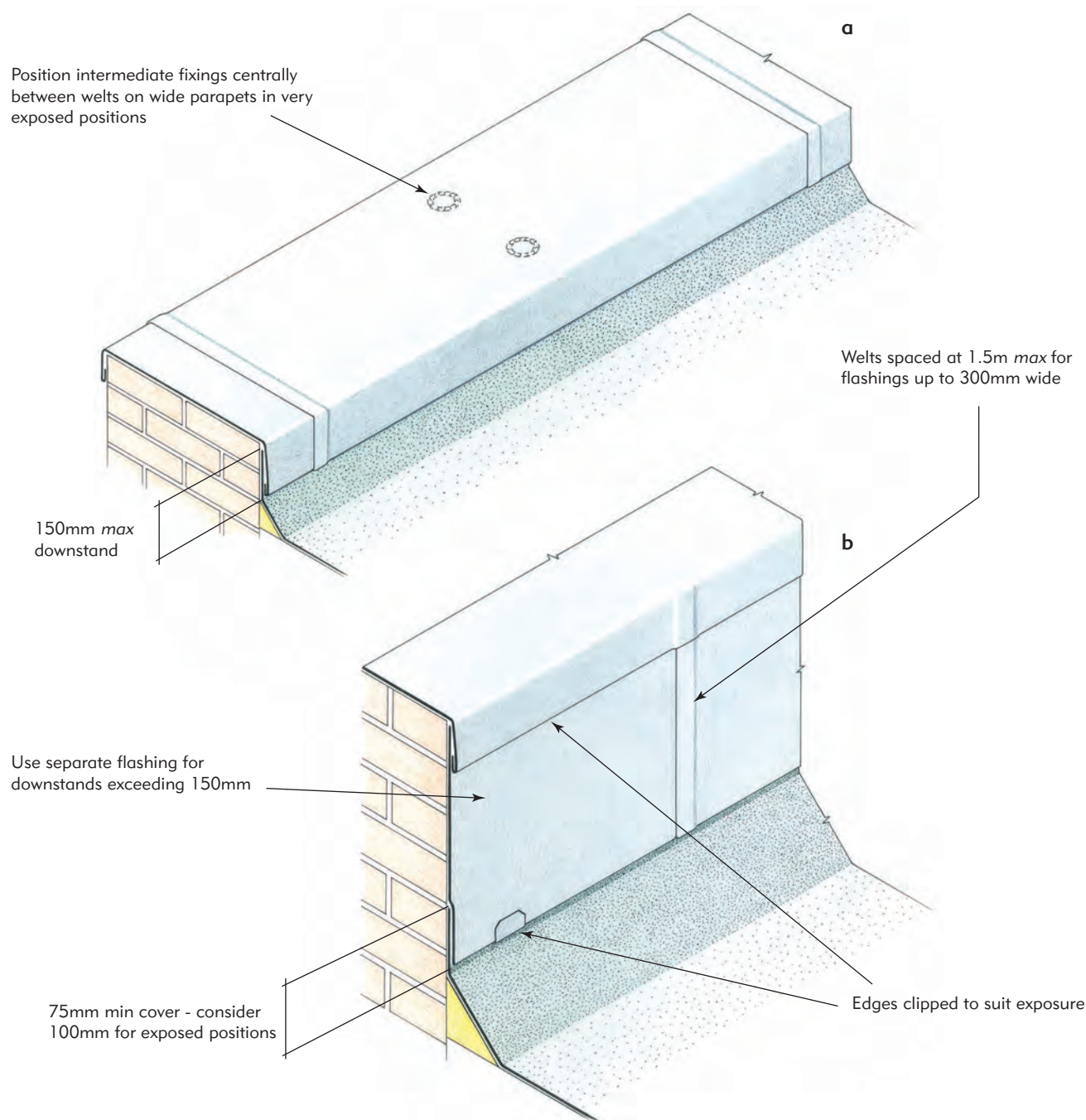


Fig 165. Pitched and curved projections



Weatherings to parapet walls

Fig 166. Weatherings to parapet walls



Weathering of parapet walls, as shown in Fig 166a, is similar to horizontal projections. Spacing of the welts is as recommended for projections with nominal fall in Table 7 (page 84), and the detailing of fixing clips in the welts and along free edges is as previously described. Intermediate fixings are not normally required because adequate fixing can be achieved in the downstand on each side of the parapet. However, for wide parapets in exposed positions, intermediate fixings may be necessary and, when used, should be positioned in the centre between the welts.

The inner edge of a parapet capping is often carried down to weather over the upstand of a roof covering or the lining of a parapet gutter. The depth of this downstand and the method of fixing the free edge are important, especially in exposed positions (Fig 48, page 30). When the downstand exceeds 150mm, it will usually be necessary to detail a separate flashing (Fig 166b; see also Figs 253 and 255, pages 158 and 161). Pitched parapet wall cappings should be joined with end-to-end laps and detailed as a pitched roof, with the edges turned down as in Fig 166.

Weatherings to parapet walls (cont.)

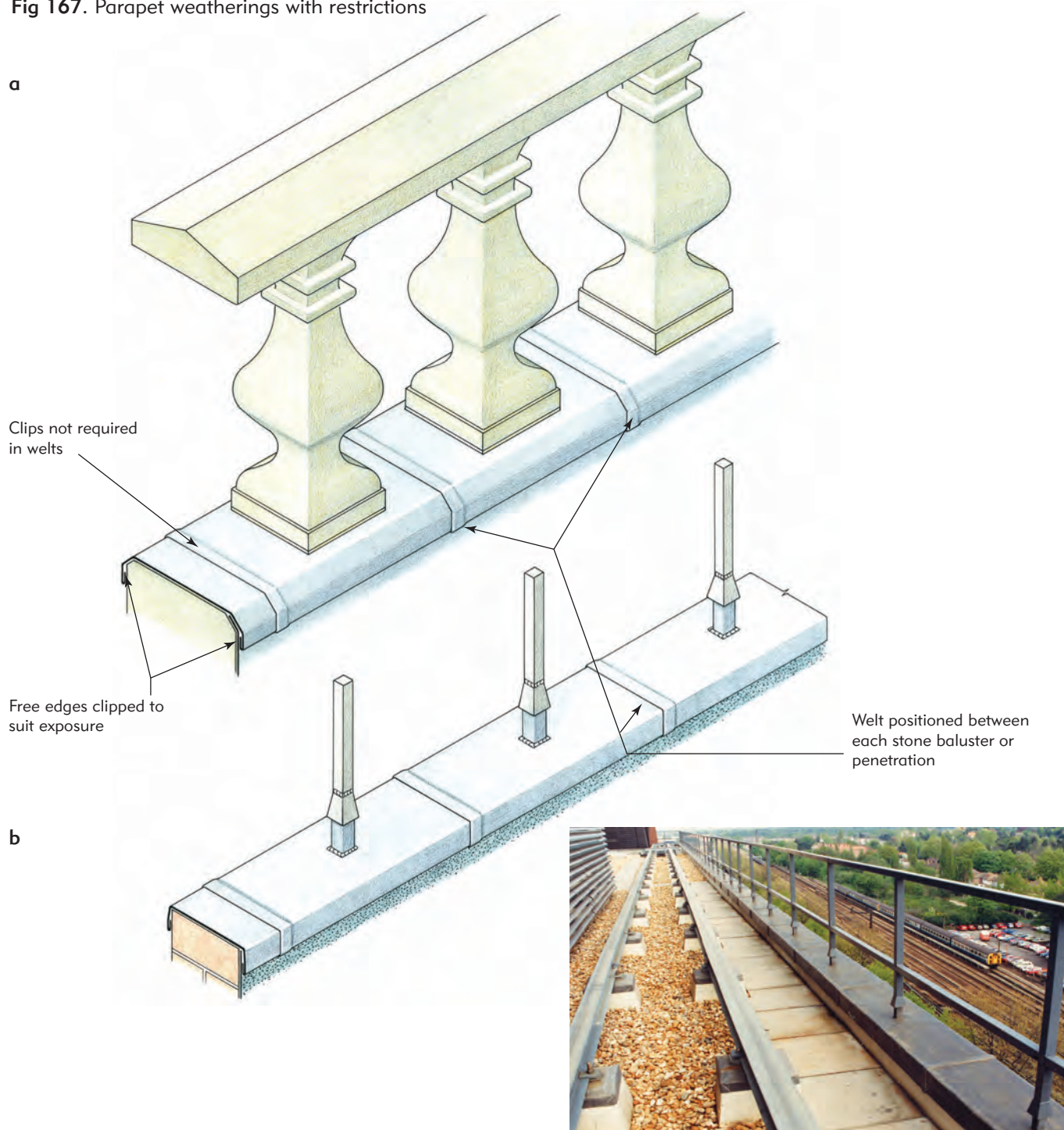
Although the welt spacing recommended in Table 7 (page 84) is suitable for most situations, there are situations (for example, window cleaning equipment or a stone balustrade mounted on top of the parapet) where the welt spacing will need to be closer.

Experience has shown that the restriction of thermal movement caused by the weight on top of the lead capping causes premature cracking. For this reason, a welt should be positioned between each bearing point or stone column (Fig 167a). In some cases, this will mean that the welts are much closer than normally recommended.

Although the weight of the balustrade will remove the necessity for clips in the welts, the free edge on both sides of the weathering should be clipped to prevent lifting in high wind conditions.

Where a railing penetrates a lead-capped parapet, a welt should be positioned between each railing upright. The penetration is made weather-tight by lead-welding a sleeve on to the capping (Fig 167b). Although the top of the lead sleeve can be sealed with mastic, a more permanent weathering can be achieved by fixing a weathering collar to the railing, as shown.

Fig 167. Parapet weatherings with restrictions



Weatherings to parapet walls (cont.)

Parapets with structural expansion joints

Where lead sheet is used to weather over structural expansion joints in flat roofs and adjoining parapet walls, the lead must be fixed so that it is not subject to flexing as the expansion joint opens and closes.

A practical way to weather an expansion joint in a flat roof is to provide a raised kerb on each side of the joint. If the expansion joint is designed for a structural movement not greater than plus or minus 5mm, the kerb can be weathered as in Fig 168. By securing the capping with the edges loosely welted over the fixing clips on each side, there will be sufficient tolerance for the lead to move freely without risk of flexing. Codes 4 or 5 lead sheet are normally used for this work, with welts spaced along the length of the kerb at 1.5m centres.

Where the expansion joint is designed for a structural movement greater than plus or minus 5mm, the capping can be detailed as in Fig 169. A loosely formed welt is provided over the joint to accommodate the extra movement.

Pieces of capping on each side of the expansion joint are joined end-to-end with welts, but these welts should be staggered to avoid complicated intersections. A supporting plate of galvanised or stainless steel is placed over the expansion joint and fixed to one side of the kerb only.

Fig 169 also shows details of where the kerb abuts a parapet wall. Allowance for structural movement at this intersection is provided by using a lap joint in the flashing at the back of the parapet and positioning a welt in the parapet capping on each side of the movement joint. It is important that all the welts are dressed down lightly.

Fig 168. Weathering over structural expansion joint

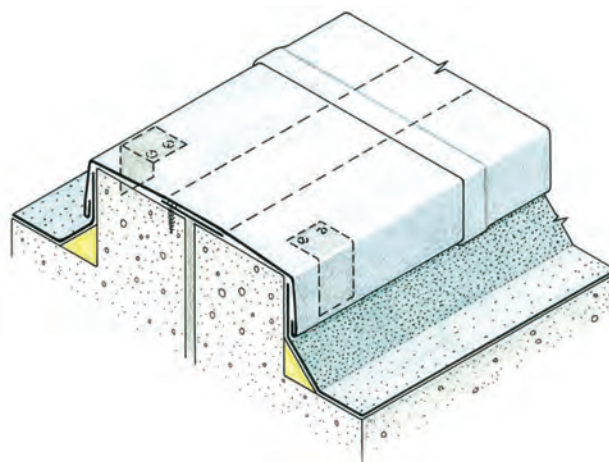
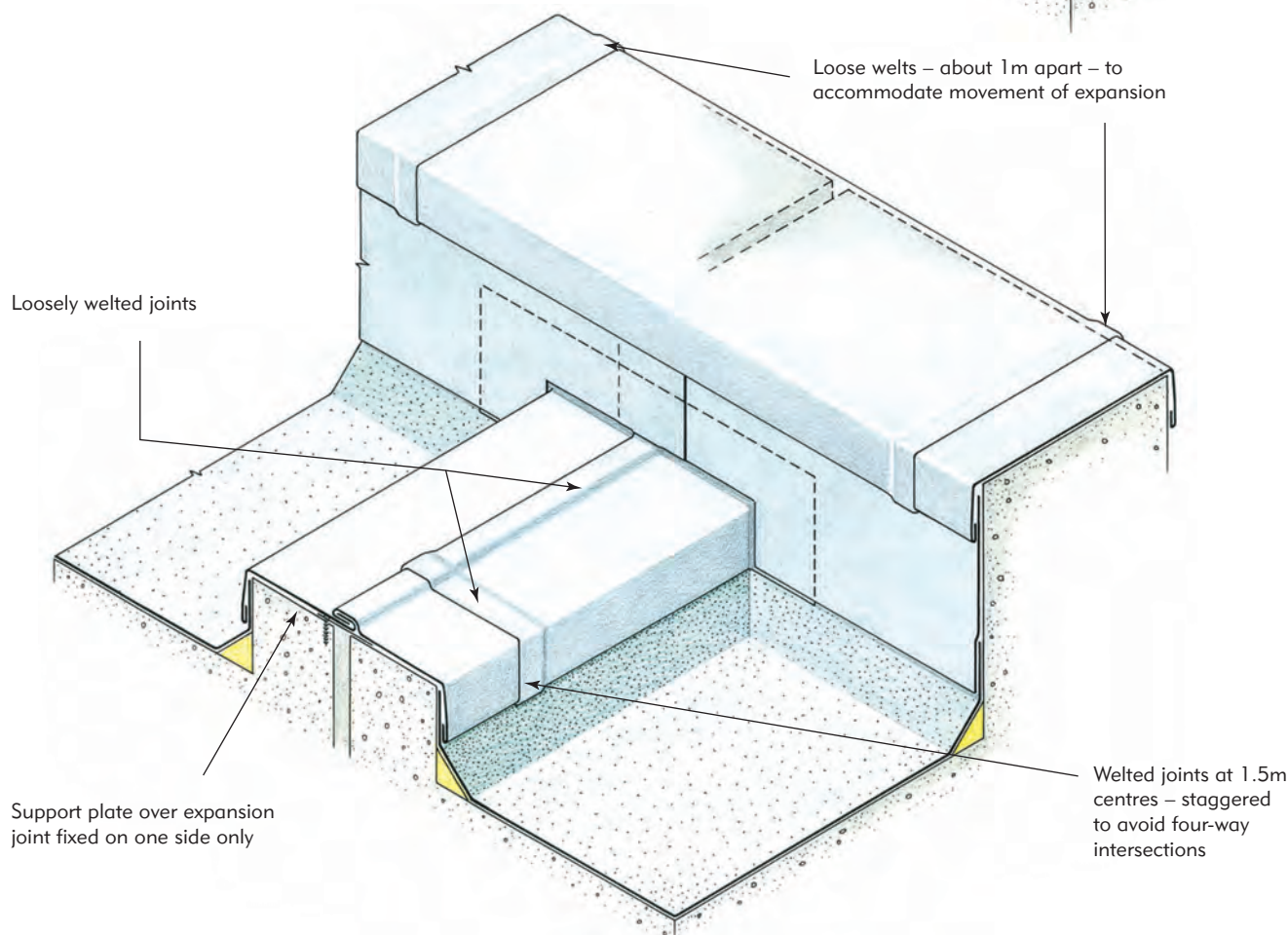


Fig 169. Weathering over larger expansion joints



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

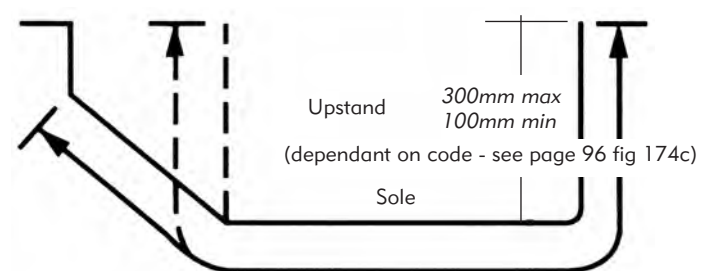


Table 8. Gutter dimensions

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 172. Roll/drip intersections for wide gutters

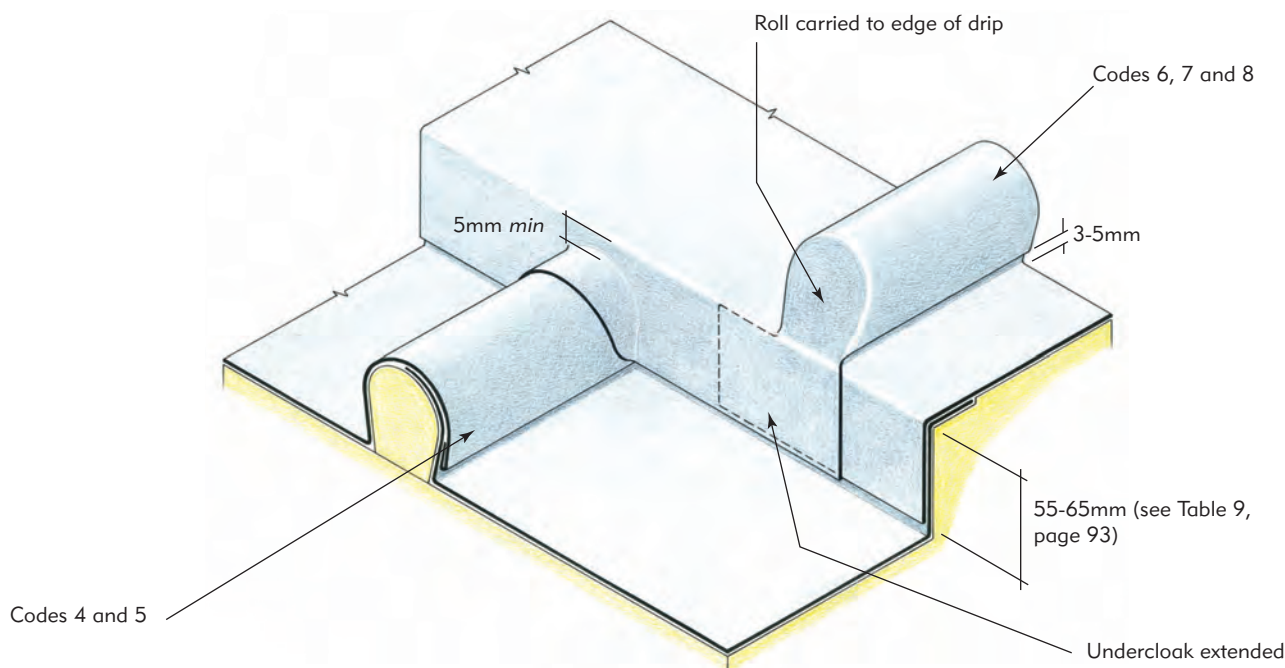
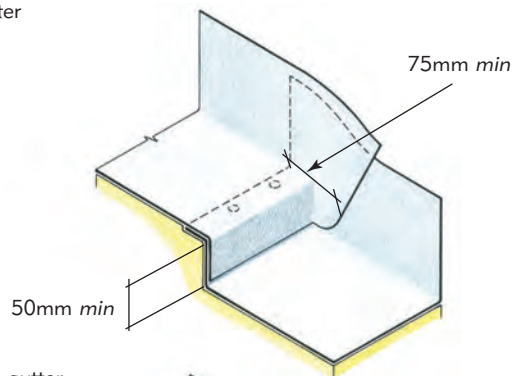
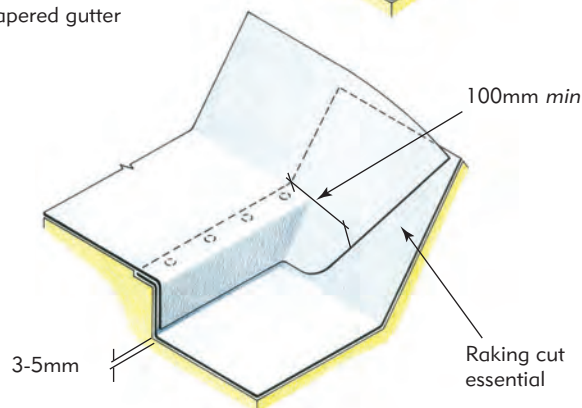


Fig 171. Drips without splash laps

a. Box gutter



b. Tapered gutter

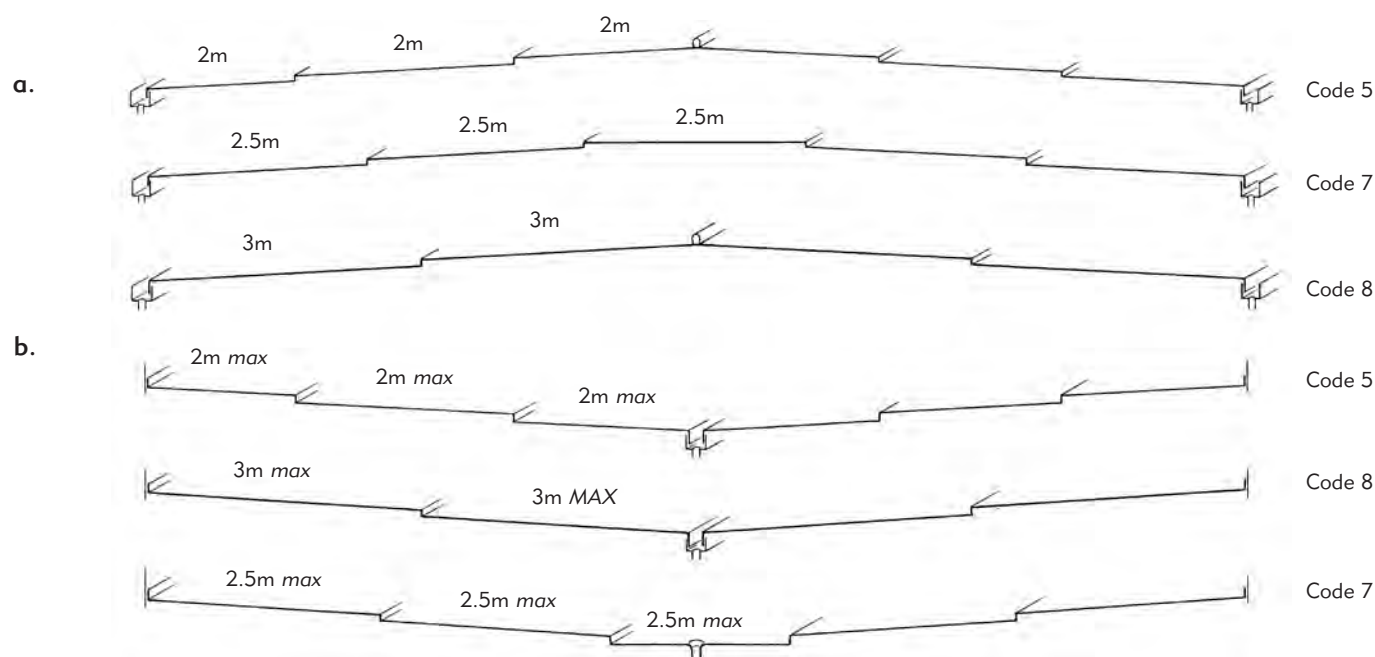


Drips without splash laps can be used in gutters up to and including 3°.

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.

Gutter linings (cont.)

Fig 173. Gutter design



Gutter design

The position of the drips in a gutter will depend on the thickness of lead sheet used for the linings, which, in turn, will depend on the position of the outlets and the amount of fall from the high point to the outlets. For new work, the designer can determine the position of the outlets and allow the required drip spacing and fall to suit the thickness of lead. With existing gutters, however, the outlet positions are usually fixed. In many cases, the amount of fall is governed by the existing wall heights.

A sectional diagram of variations in gutter design is shown in Figs 173a and b. The gutter as shown in Fig 173a, has a high point in the centre. If code 5 is used to line this gutter, six bays, each 2m in length, will be required, with four drips and a transverse roll at the high point. For code 7, the same gutter could be lined with five bays, each 2.5m in length, without a centre roll. If code 8 is specified, the gutter will require four bays, each 3m in length, with two drips and a roll at the centre. All three designs are correct because the bay sizes do not exceed those shown in Table 8 (page 93).

In some cases, the use of a thicker lead in longer pieces will be more economical than a thinner material with more drips. With long tapered gutters in particular, each drip increases the width of the gutter, thereby necessitating the use of rolls to divide the wide bays. Combine this with the cost of constructing more drips, and the cost required to use a thicker lead will often prove less overall.

Occasionally designers will specify a thicker code than that required for the drip spacing – for example, code 6 instead of code 5 for the 2m bays shown in Fig 173a. This may be to suit the high quality of a building, to allow for foot traffic or, perhaps, to provide an extra safety factor to ensure long life.

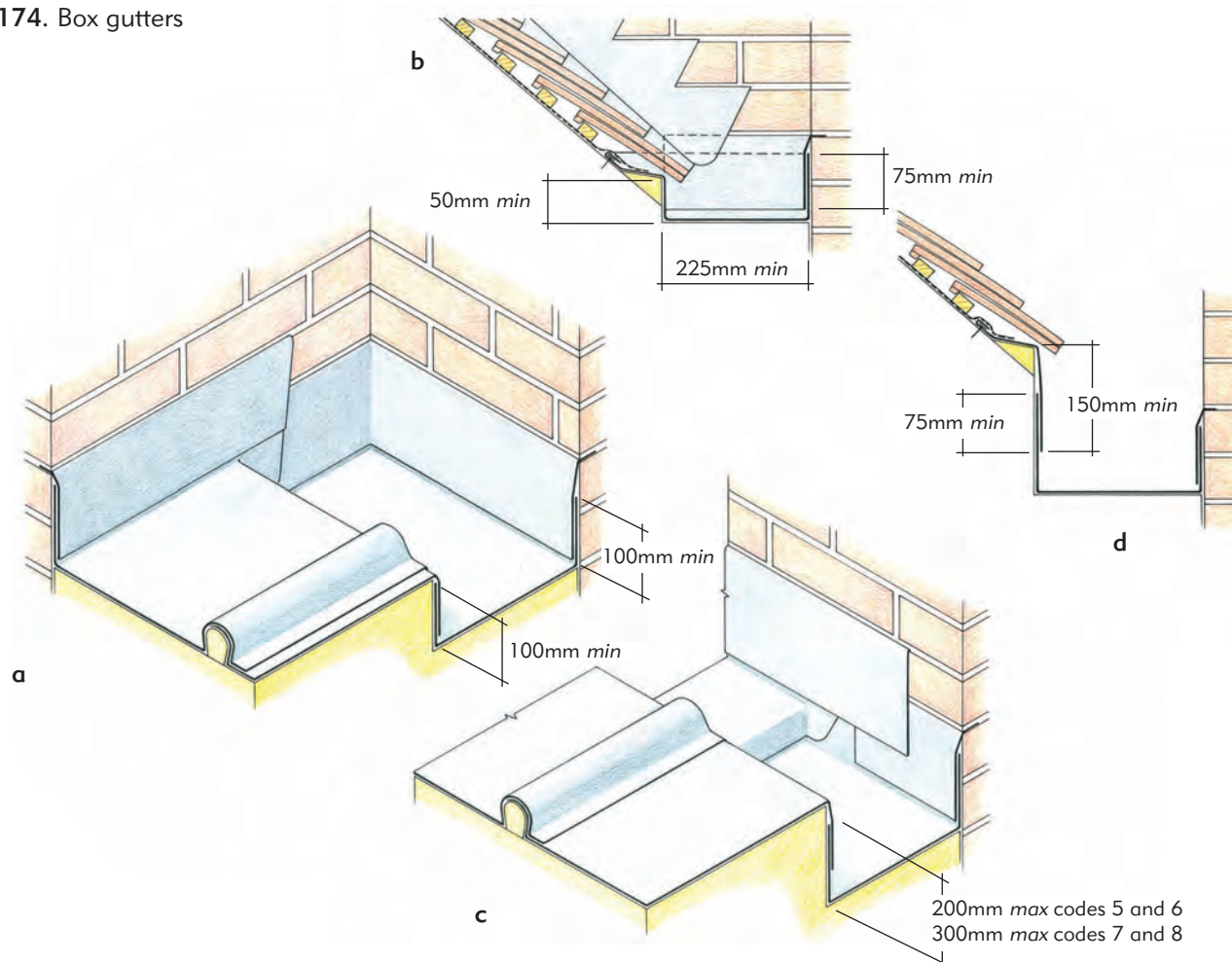
Fig 173b shows a 12m-long gutter with a central catch pit outlet. Six bays of code 5, with two drips on each side, would be required to line this gutter to keep within the maximum bay length of 2m for this thickness of lead sheet. However, the use of code 8 would allow a maximum bay length of 3m and a correct design would be two bays on each side. If the outlet is connected to the sole of the gutter instead of using a catch pit, code 7 would be suitable, as shown. When using an outlet connected directly to the sole of the gutter, it is important to fit the bay loosely between the drips to allow for thermal movement. In addition, consideration must be given to the rainwater discharge from this type of outlet when compared with an outlet from a catch pit (see page 103).

Methods of fixing

Gutter lining pieces are held in position by nailing the undercloak into the rebate at the top of the drip. If a transverse roll is used at the high point in a gutter, the undercloak is nailed to the wood roll. In most situations, the sides of the gutter linings should not be nailed because this restricts free thermal movement. However, if the fall of the gutter exceeds 1 in 60, it will be necessary to provide a few extra fixings to prevent the linings from gradually slipping down the fall. These fixings should be positioned in the top third of the length of each piece so that thermal movement is not unduly restricted.

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).



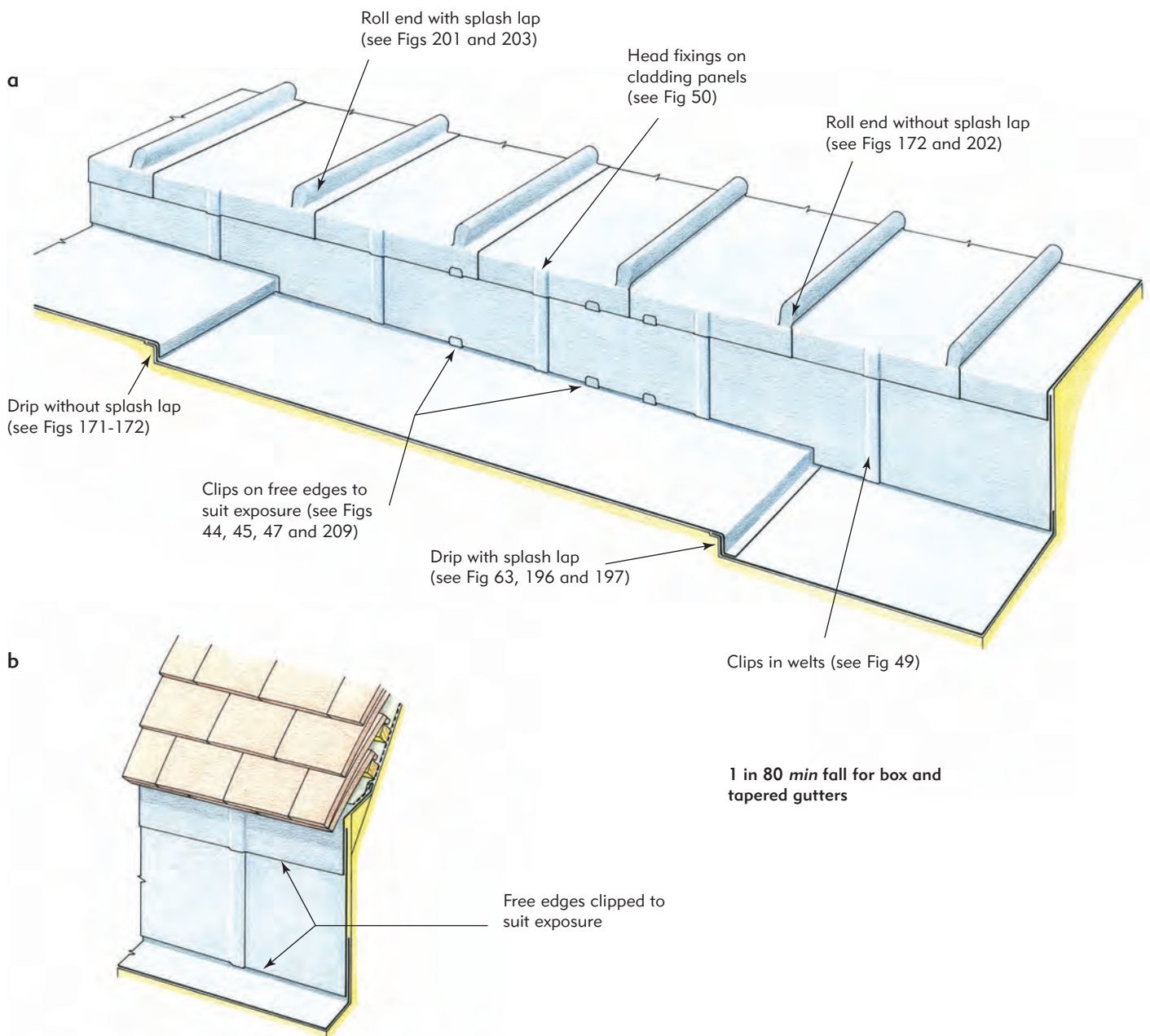
Gutter linings (cont.)

Deep-sided gutter

With deep-sided box gutters, a separate piece of lead sheet is used to weather between the gutter upstand and the roof covering. This apron should be fixed in short lengths as vertical cladding, each length being joined by welts. Spacing of the welts will depend on the depth of the cladding and the thickness of lead sheet used (Fig 253, page 158). A practical and economical design, avoiding the use of intermediate fixings, is to space the welts centrally between the rolls, as shown in Fig 175a.

When the roof is covered with tiles or slates, the detailing is similar, except for a separate flashing that is used to weather over the top of the cladding panels (Fig 175b). In both cases, the panels should be fixed at the top with two rows of nails at 75mm centres or, if the length of the panel does not exceed 500mm, one row at 50mm centres. Clips should be provided in the welts and along the free edges to suit the exposure of the building.

Fig 175. Deep-sided gutter



Gutter linings (cont.)

Box gutter corners

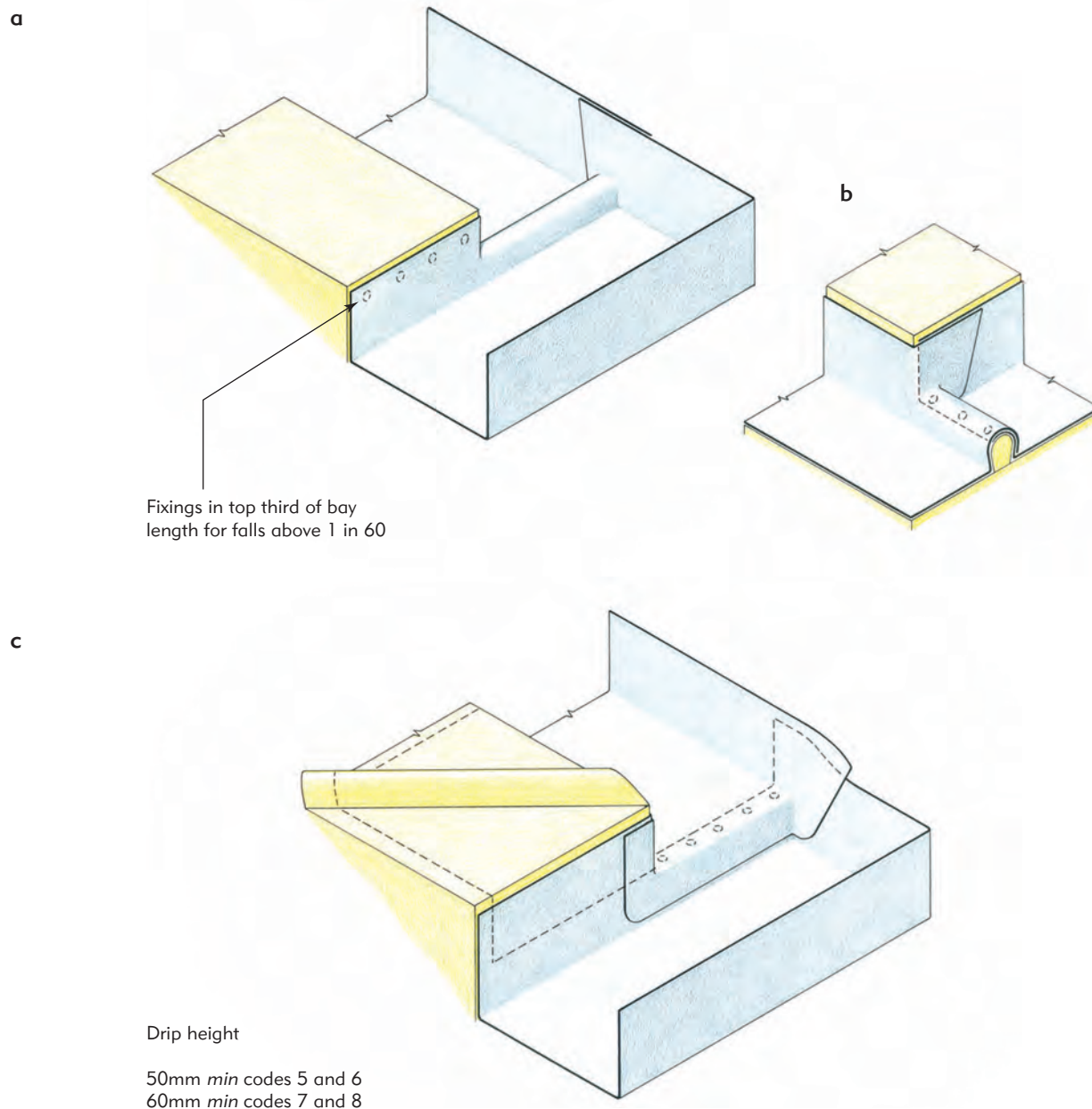
At both internal and external corners, a joint should be introduced to allow for thermal movement at the change in direction of the gutter. If the corner is at the high point in a gutter with a fall in both directions, a roll is introduced (Figs 176a and b). Although it is possible to position the roll at 45°, this makes it difficult to form the roll ends, so fixing the roll as shown will be more practical.

For normal gutter falls, the two bays will be held in position by the nails in the undercloak on one bay and the grip of the overcloak for the other bay.

However, if the fall is more than 1 in 60, additional fixings should be positioned along the upstand in the top third of the bay lengths only.

Where the gutter corner occurs in the fall, a drip is introduced (Fig 176c). The drip height in this position should not be less than 50mm for codes 5 and 6, or 60mm for codes 7 and 8. Nailing the undercloak into a rebate will hold the bay in position but, again, additional fixings will be required in the upstand for falls above 1 in 60.

Fig 176. Box gutter corners



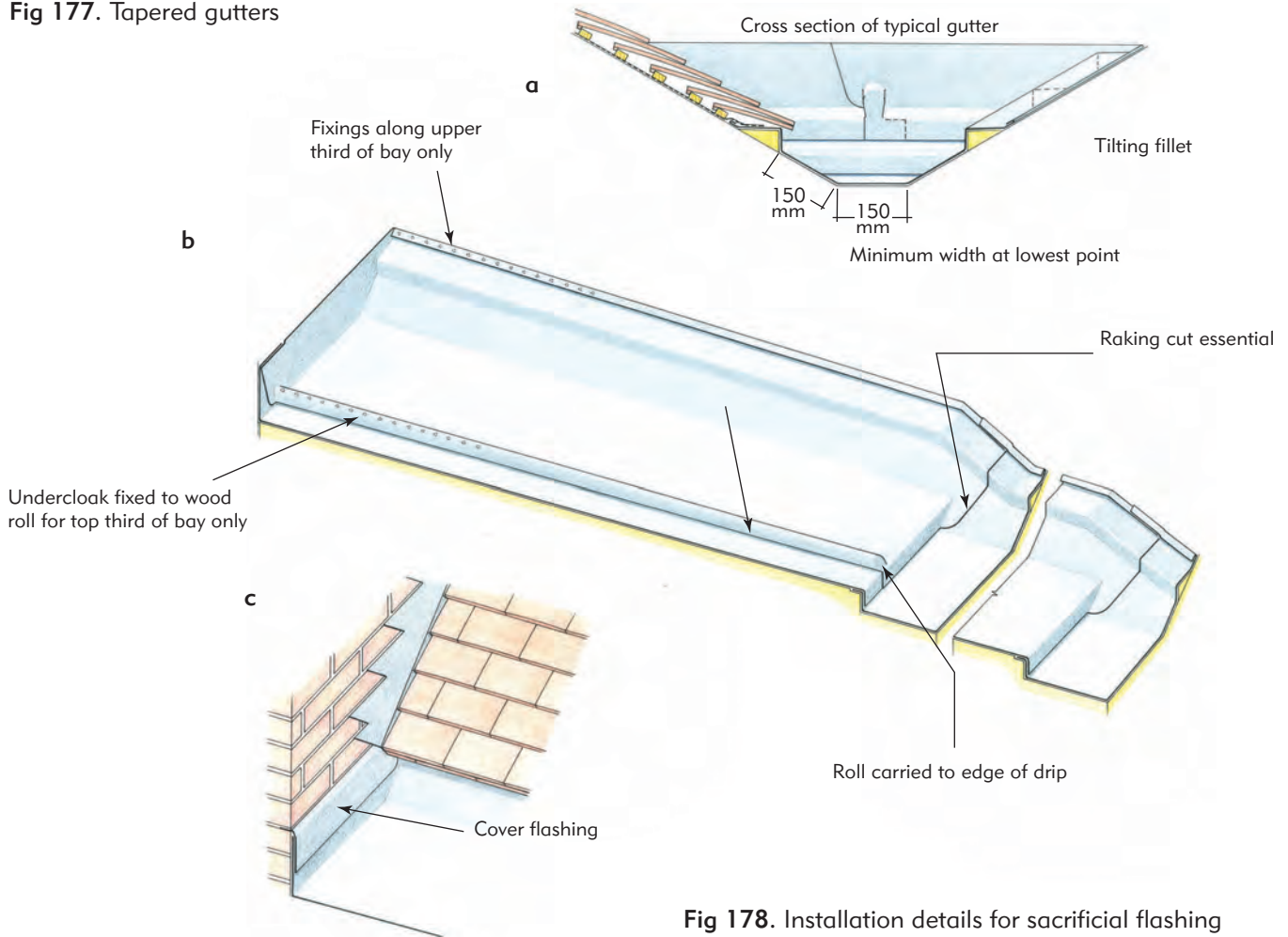
Gutter linings (cont.)

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).

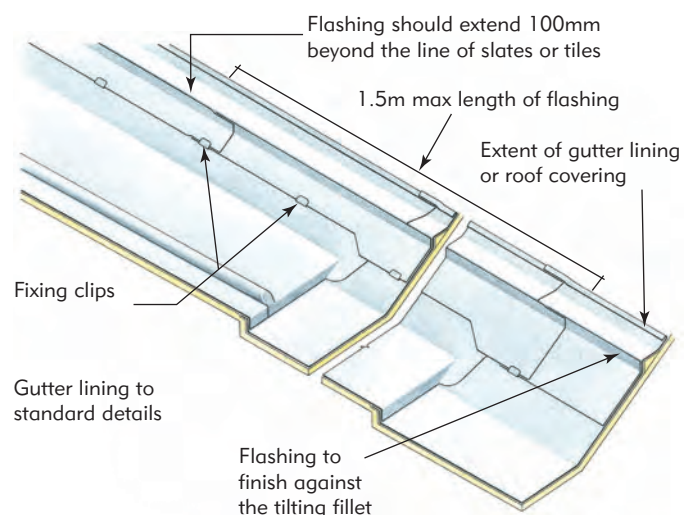
Fig 177. Tapered gutters



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.

Fig 178. Installation details for sacrificial flashing



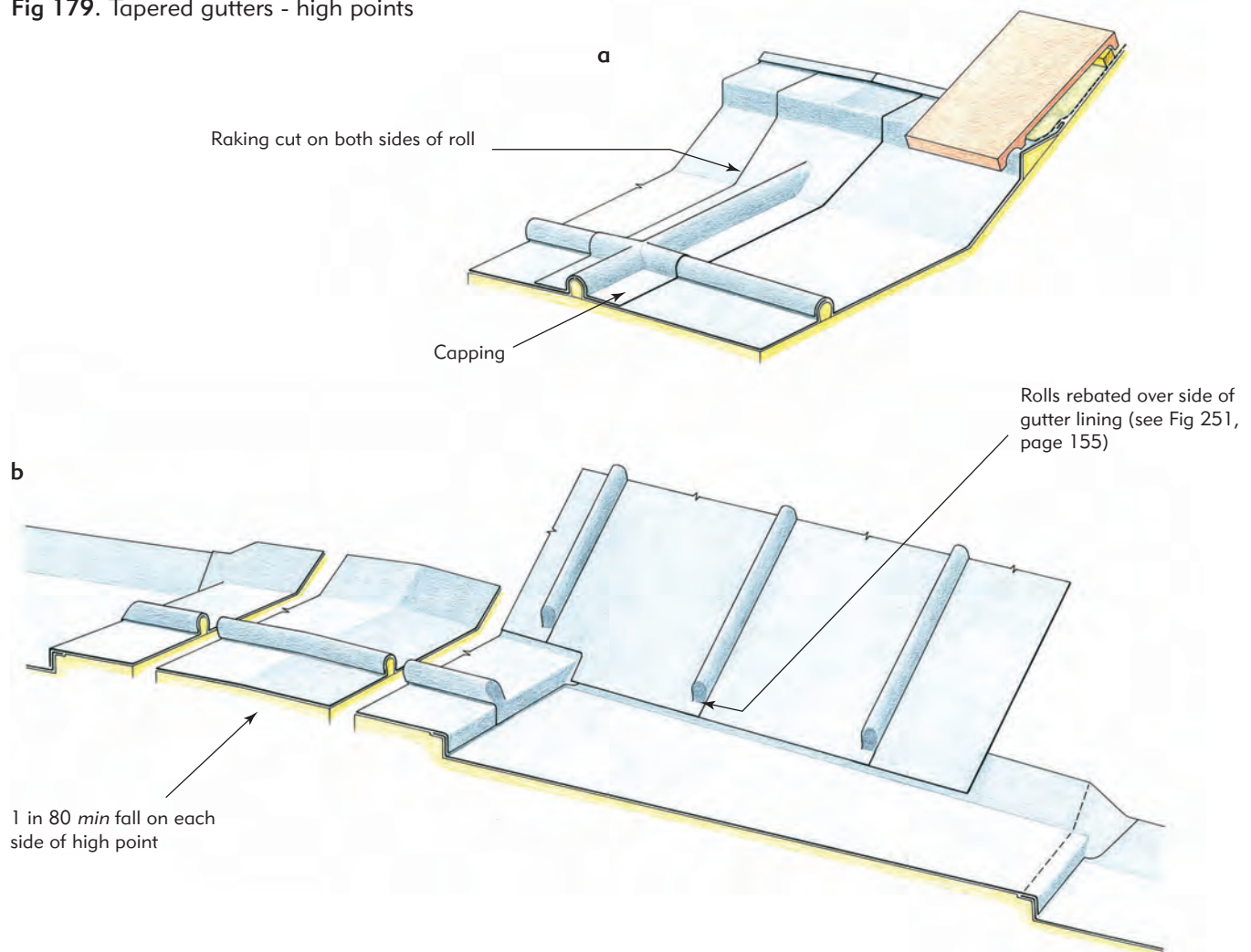
Gutter linings (cont.)

Tapered gutters

In situations where there is a high point in a gutter with the bays falling in opposite directions, a transverse roll is used with the top bays formed as an undercloak and overcloak. However, if rolls are also used to divide wide sections at the top of the gutter, a capping is used to weather the roll intersections (Fig 179a). An alternative with the top bay spanning the centre point is shown in Fig 179b. If the pitched roof is covered with lead sheet, the tilting fillets are omitted and the roofing bays finished as shown.



Fig 179. Tapered gutters - high points



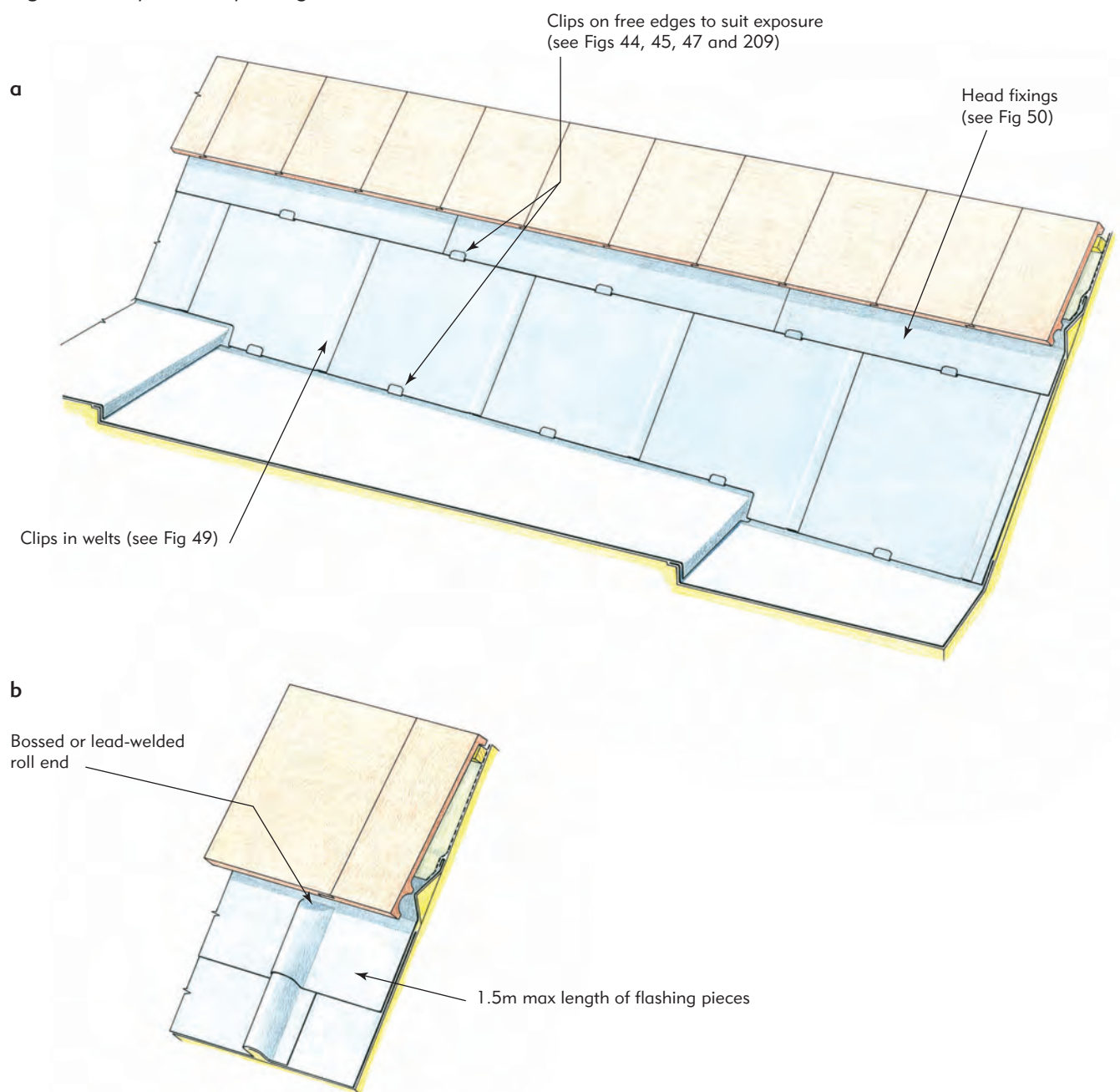
Gutter linings (cont.)

Deep-sided tapered gutters

In most situations, the tiles or slates that cover the pitched roof at the side of a tapered gutter are finished at the bottom of the roof slope with a cut edge following the fall of the gutter. A tilting fillet is positioned along the side of the gutter and the slates or tiles are finished as shown in Fig 177a (page 98). However, for aesthetic reasons, or to avoid cutting the slates or tiles, the gutter side is sometimes finished as shown in Fig 180a.

Sizing and fixing of the lead panels at the side is similar to that described for deep-sided box gutters. With very large areas of low-pitched roofing in highly exposed positions, it may be necessary to use rolls instead of welts to avoid the risk of surcharging the welts during heavy rain (Fig 180b).

Fig 180. Deep-sided tapered gutters



Gutter linings (cont.)

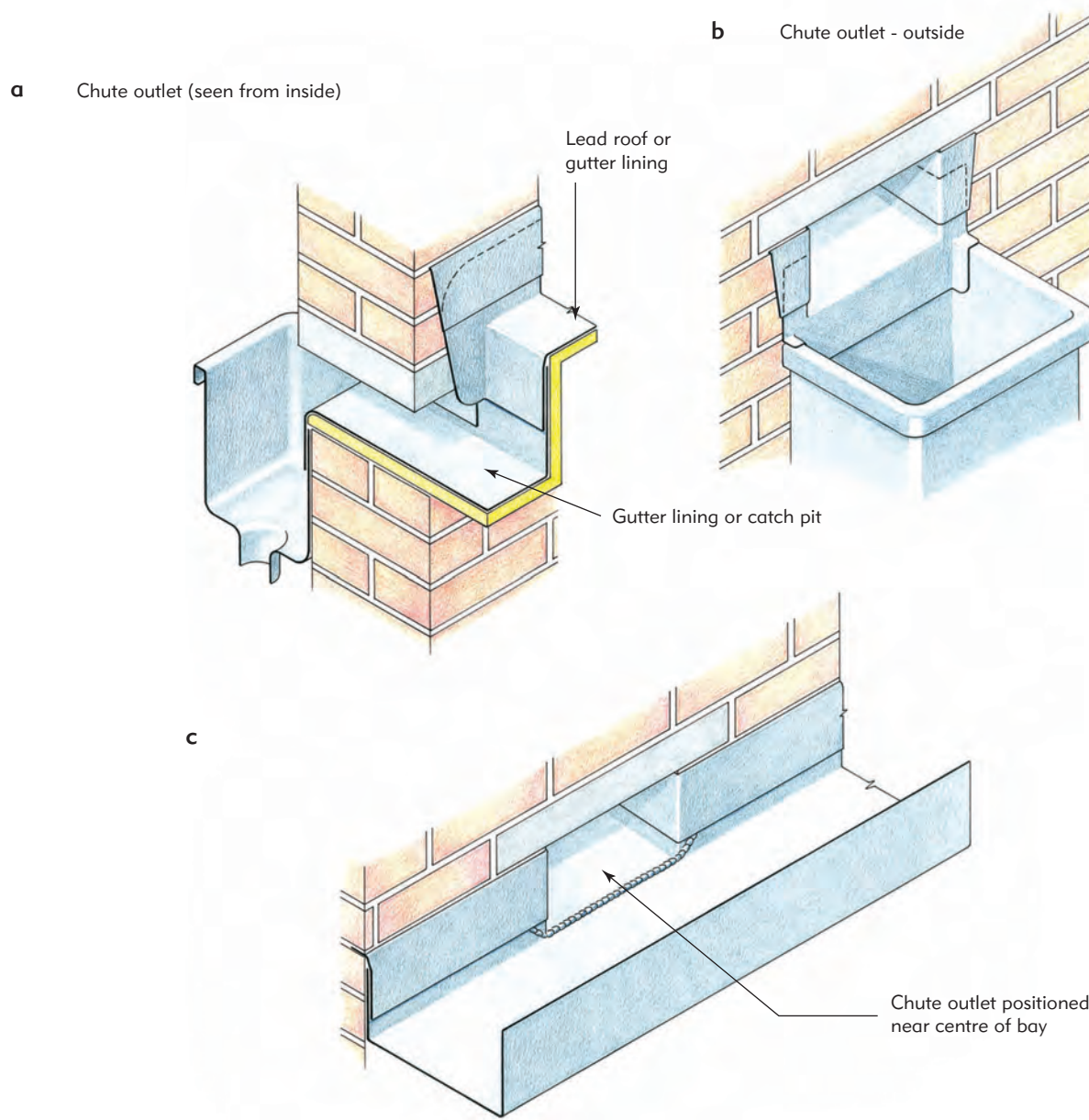
Outlets to box and tapered gutters

– chute outlet

A chute outlet is where the sole of the gutter or bottom of the catch pit is taken through the wall to discharge into a hopper head and external rainwater pipe. This form of outlet has very good flow capacity and is not prone to blockage by leaves or other debris. The flow of water will normally carry any leaves etc through the wall into the hopper head. Although it is possible for blockage to occur in either the head or the pipe, any overflow that does occur will be on the outside of the building, where it can be readily seen and rectified. With a brick wall, two courses are usually left out to provide an opening about 150mm high.

The gutter board is carried through the wall with the outer edge well rounded. Fig 181a shows the finish on the inside, which will vary depending on the height of the gutter sides. The finish on the outside of the wall is as shown in Fig 181b, with the shaping required being done by bossing or lead-welding as shown in Figs 199 and 200 (page 116). If the chute outlet is at the side of the gutter, as in Fig 181c, it should be positioned near the centre of the gutter bay with the chute section loosely fitted at the sides to allow for thermal movement.

Fig 181. Chute outlets



Gutter linings (cont.)

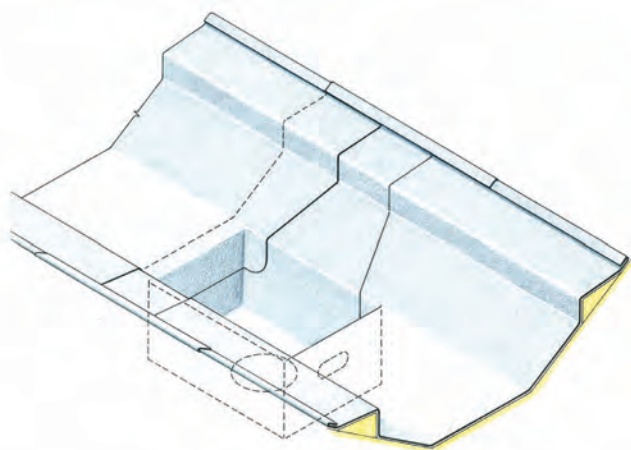
Outlets to box and tapered gutters – catch pits

A catch pit, in which a small head of water can be built up to increase the flow of rainwater, is used normally where an internal down pipe is to be fitted. Preferably, a catch pit should be not less than 150mm deep and should have a length not less than the width of the gutter. If the depth of a catch pit is less than 150mm, the length should be increased to avoid surcharging of the pit in storm conditions. The diameter of the outlet will depend on the calculated flow of rainwater. An overflow pipe should be fitted to a catch pit in case of blockage by leaves and other debris. The invert of the overflow should be about 50mm below the top of the catch pit.

Catch pits can be bossed to shape but, normally, they are more economically made by cutting, folding and lead-welding. For a typical and simple form of catch pit, the work is set out and cut, as in Fig 182a, then lead-welded on the bench with flat butted seams (Fig 182b). Whether or not the down pipe spigot is welded to the bottom of the pit at this stage will usually depend on the amount of access beneath the gutter. Fig 182c shows the catch pit in position with gutter bays and cover flashings also fitted.

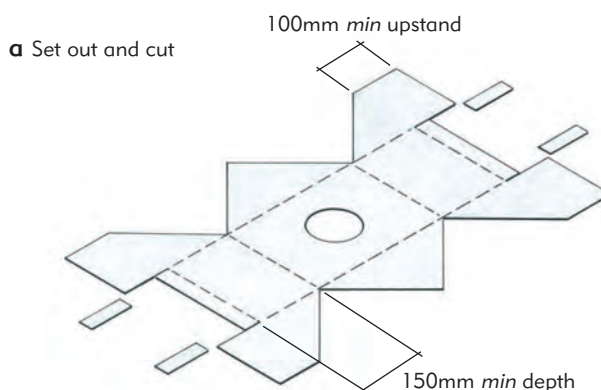
This basic method of forming and fitting a catch pit can be easily modified to suit other situations such as when the roof adjoining the gutter is tiled or slated (Fig 183).

Fig 183. Catch pit in tapered gutter

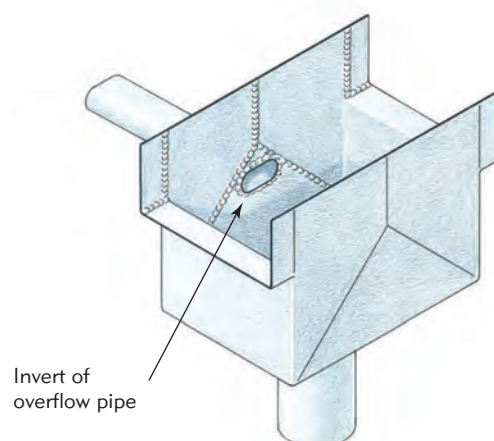


Note: Width of catch pit must always equal width of gutter sole

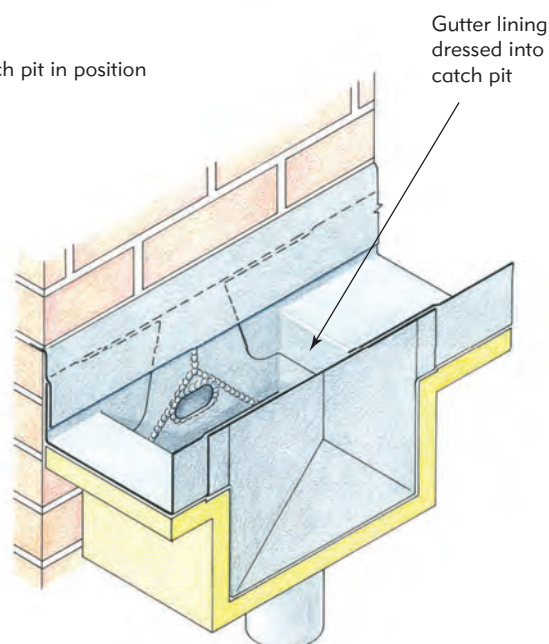
Fig 182. Catch pits



b Folded and lead-welded



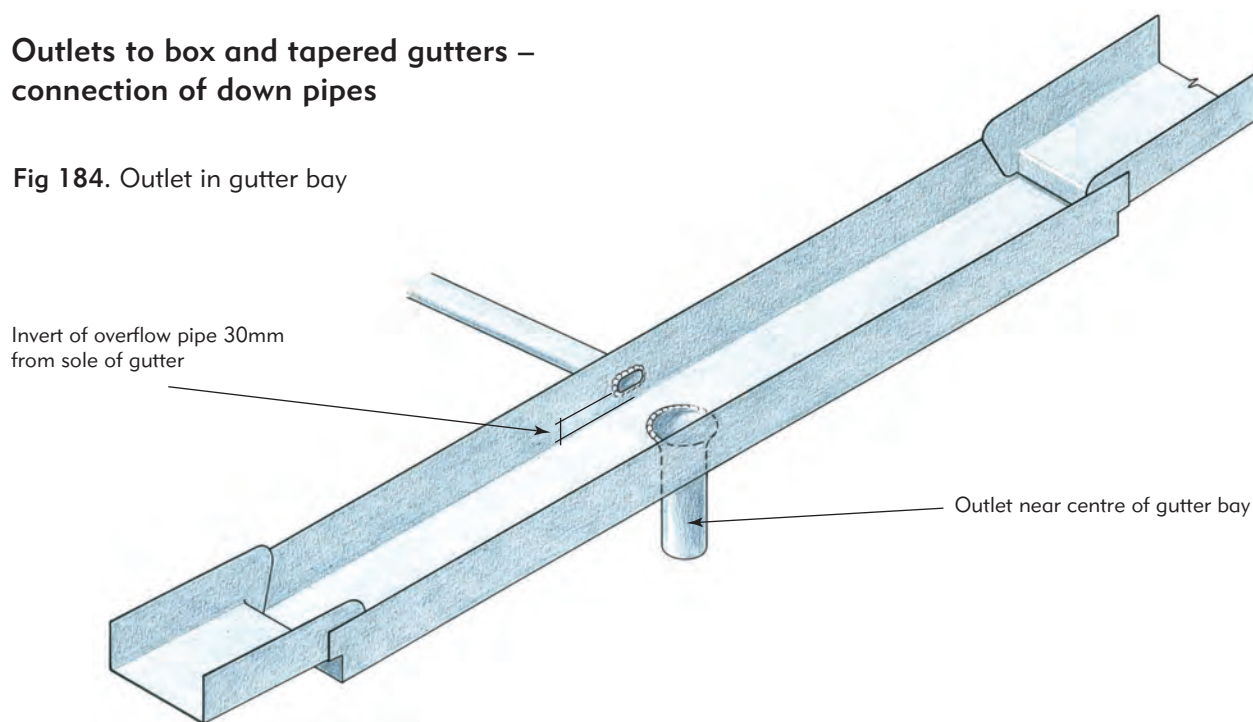
c Catch pit in position



Gutter linings (cont.)

Outlets to box and tapered gutters – connection of down pipes

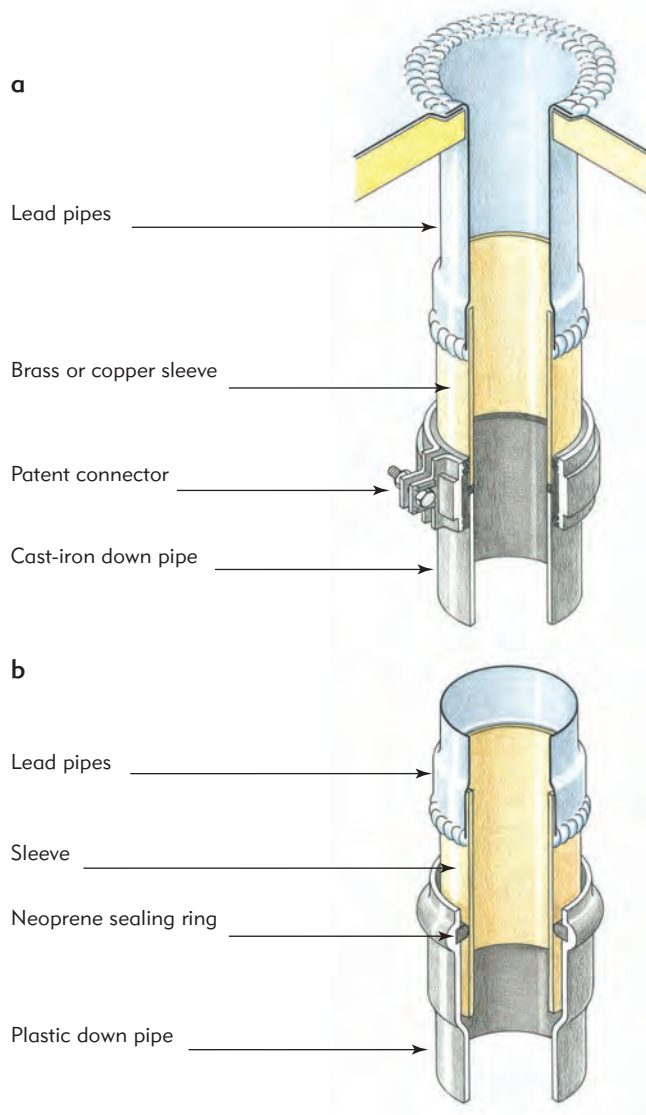
Fig 184. Outlet in gutter bay



The alternative to fitting an internal down pipe to a catch pit is to connect the pipe directly to a lead spigot welded to the sole of the gutter (Fig 184). This method is often used where the available fall between the high point in a gutter and the outlet position is insufficient to permit the fitting of a catch pit. A bay outlet should be positioned near the centre of the bay and it is important to size the outlet so that the adjacent drips are not surcharged in storm conditions. An overflow should be fitted in the gutter upstand adjacent to the outlet and the invert of the overflow pipe should be 30mm from the sole of the gutter.

Figs 185a and b show methods for connecting the outlet from a lead-lined gutter or catch pit to a cast-iron or plastic down pipe. The length of the lead spigot will depend on the amount of access below the gutter and whether the spigot and thimble can be jointed in position. In many cases, the lead spigot is joined to the pipe, as shown, and then the pipe, thimble and spigot are pushed up from below into a hole cut into the gutter lining or catch pit. After dressing the top of the lead spigot to form a lapped joint, the work is welded in position. In all cases, it is important that the down pipe is adequately supported.

Fig 185. Connections of down pipes



Gutter linings (cont.)

Guidelines on the size and position of gutter outlets

The minimum diameter of a gutter outlet should be 75mm, although diameters of 100mm and more will often be required to accommodate the maximum flow rate, as well as allowing a factor of safety.

Tests carried out at Brunel University, Uxbridge, have shown that the type and position of the outlet in a gutter determines the flow capacity. Increasing the width of a gutter does not increase the flow capacity, but the minimum width of a box gutter should be 225mm (Fig 186a). The sole of a tapered gutter should not be less than 150mm (Fig 186b).

Chute outlets discharging into external rainwater pipes are the most effective and safe way to drain box and tapered gutters. However, where a side chute outlet is used (Fig 181c), it should be positioned near the centre of the bay.

Whenever possible, the outlet from a catch pit should be positioned in the bottom of the box (Fig 186c). Side outlets have less flow capacity but the use of a rectangular outlet will give a greater flow capacity than a round outlet of the same cross-sectional area (Fig 186d).

An outlet connected directly to the sole of a gutter bay has more flow capacity than a side outlet, but less than a catch pit with a bottom outlet. A bay outlet should be positioned near the centre of the bay (Fig 186e).

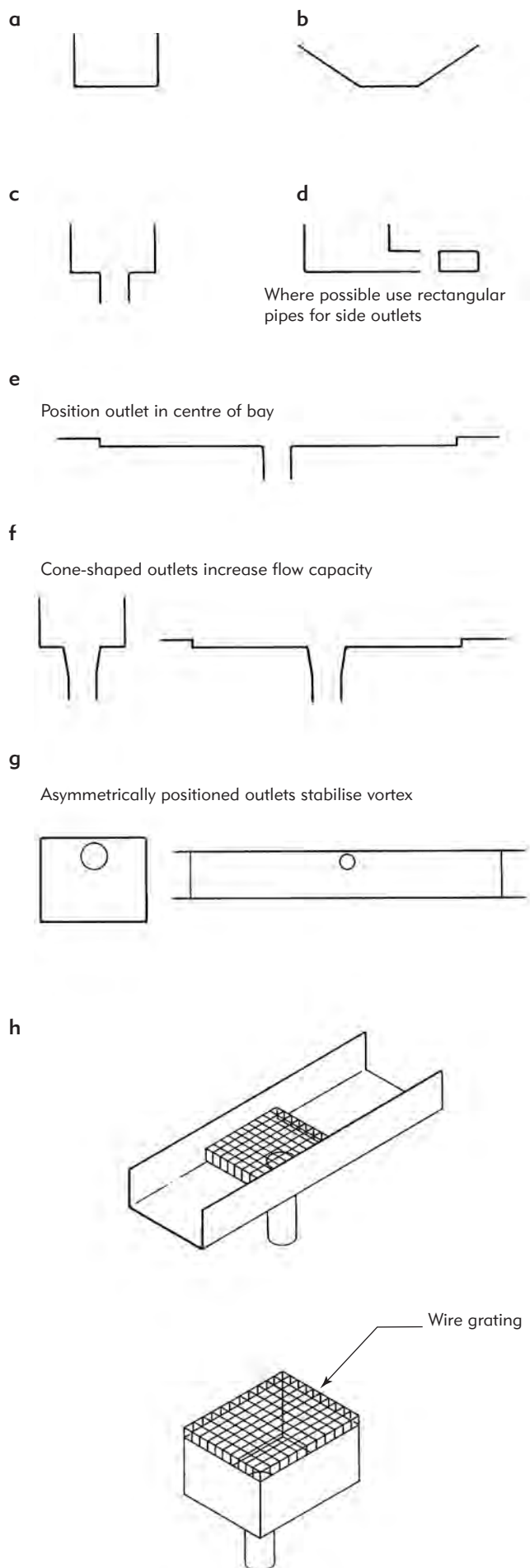
Cone-shaped outlets stabilise the vortex and increase outlet capacity considerably (Fig 186f). Positioning the outlet asymmetrically in the catch pit or gutter bay also stabilises the vortex and increases outlet capacity (Fig 186g).

A wire grating over the outlet area will not restrict flow capacity but tends to stabilise the vortex (Fig 186h). An overflow pipe should be fitted to all catch pits and bay outlets to warn of blockage of the gutter or down pipe by leaves or other matter.

To avoid blockage and water ingress problems caused by thawing ice and snow, consider the use of trace heating tapes.



Fig 186. Outlets



Neoprene expansion joints

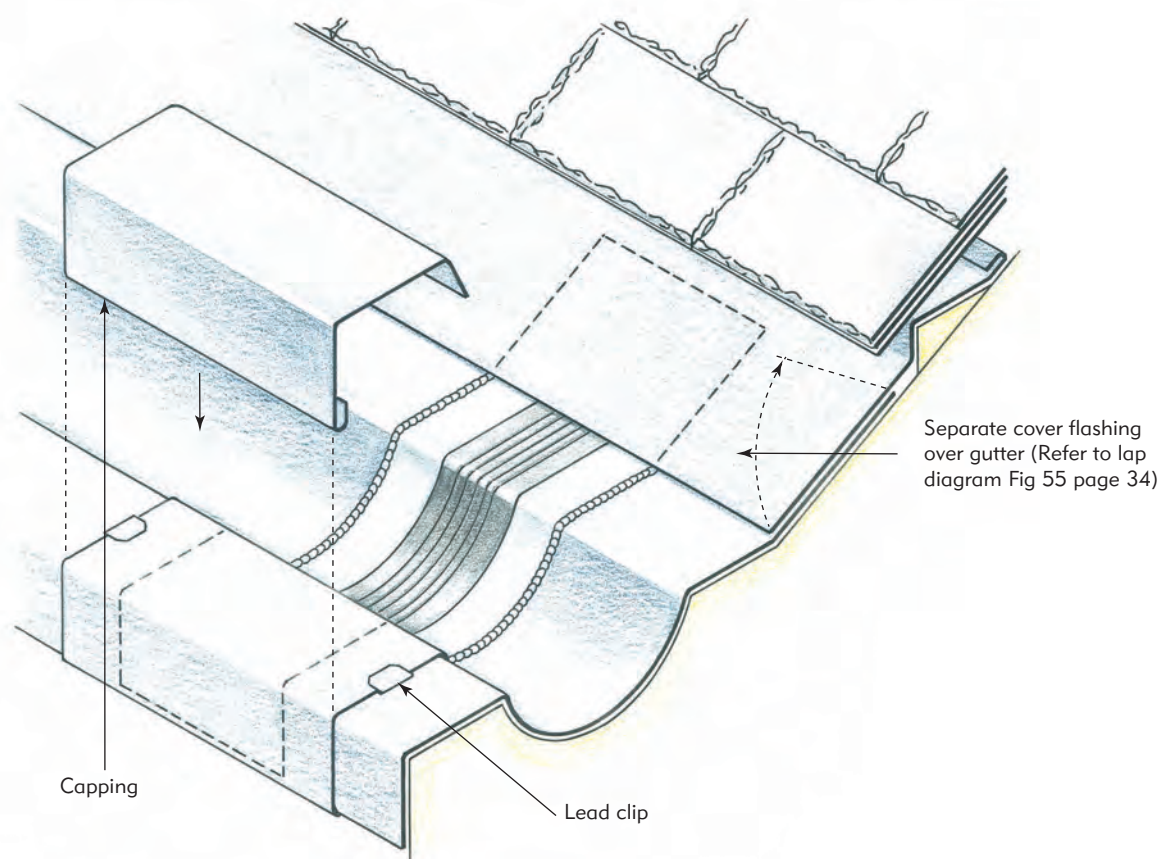
Neoprene expansion joints were first used in Europe with zinc and copper linings and have been in use with lead sheet since the early 1990s. They were originally intended to replace welted expansion joints in wall head gutters, in situations where it was impractical to provide steps in construction and the overall girth of the gutter was not more than 800mm. This would therefore eliminate the need for wood-cored rolls (see Fig 170 and Table 8, page 93).

Neoprene expansion joints have been used in a variety of wall head gutter applications and appear to be providing a good service life to date. The manufacturer's or supplier's instructions should be followed when installing these products and everyone involved should be aware that they only carry between a 5 and 10-year guarantee, depending on the manufacturer.

The joints are normally spaced at about 2m centres for code 5 and 1m either side of fixed points such as outlets and changes in direction. Where the gutter lining turns down the front edge of a gutter, the joints can be covered with a piece of lead sheet fixed as shown in Fig 187, and clipped to protect against wind uplift (Fig 48b, page 26). Note the detailing of a separate flashing over the gutter upstand at the back to allow for ease of repair or replacement without removing the lower course of slates or tiles (Fig 55, page 34). Flashing lengths should not exceed 1.5m.

The main factors influencing specification are BS EN 1990:2002 Basis of Structural Design and the anticipated life of the building concerned. Where maximum service life is required, standard drip details should be adopted. It would be advisable to ensure that any voids created under the substrate are adequately ventilated.

Fig 187. Flexible expansion joint



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.

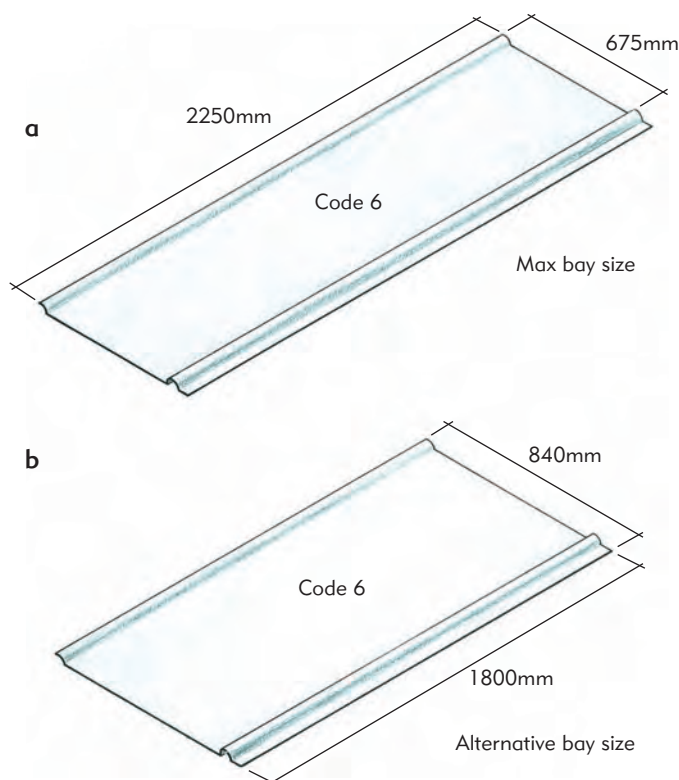


Table 10 Flat roofs - spacing of joints

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°

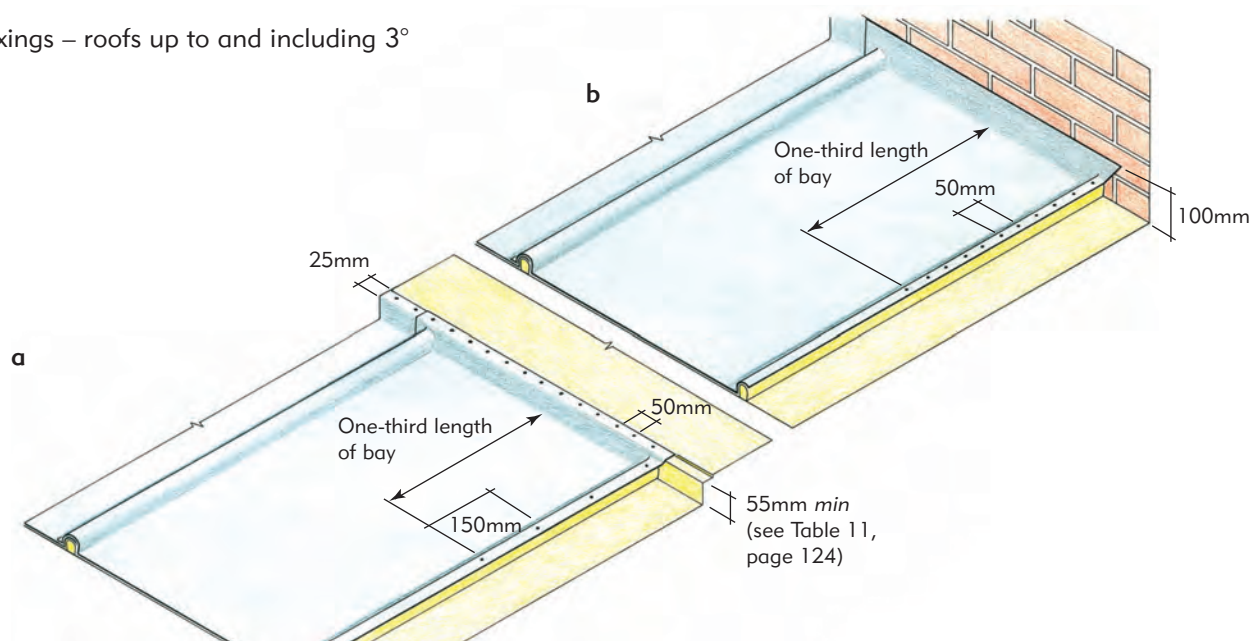
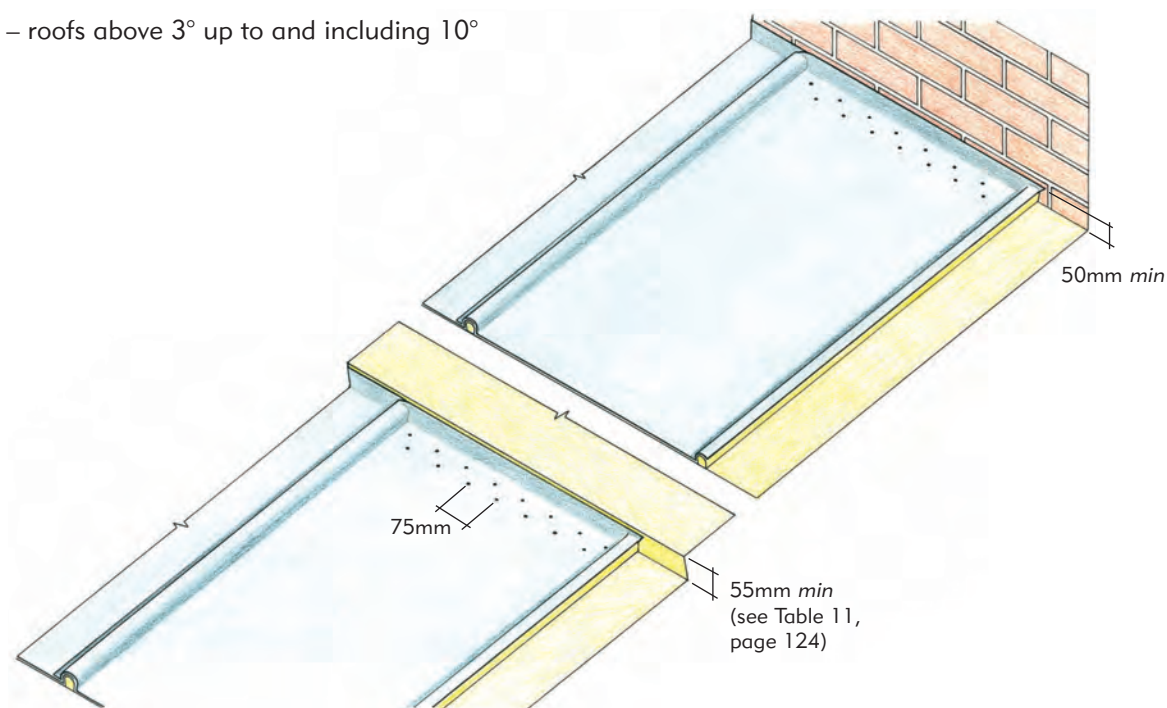
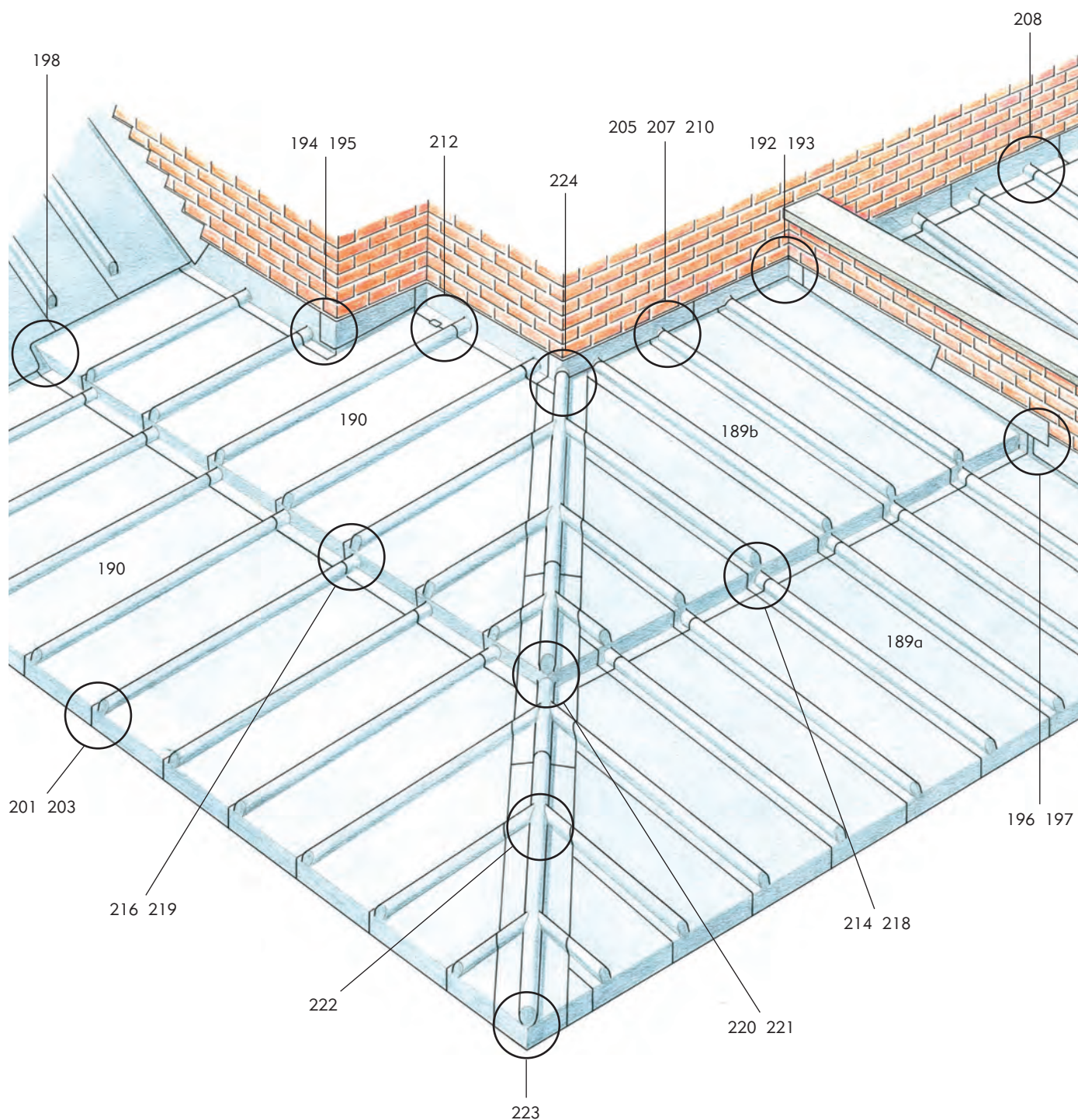


Fig 190. Fixings – roofs above 3° up to and including 10°



Flat roof coverings (cont.)

Fig 191. Lead-covered roofs up to 10°



Flat roof coverings (cont.)

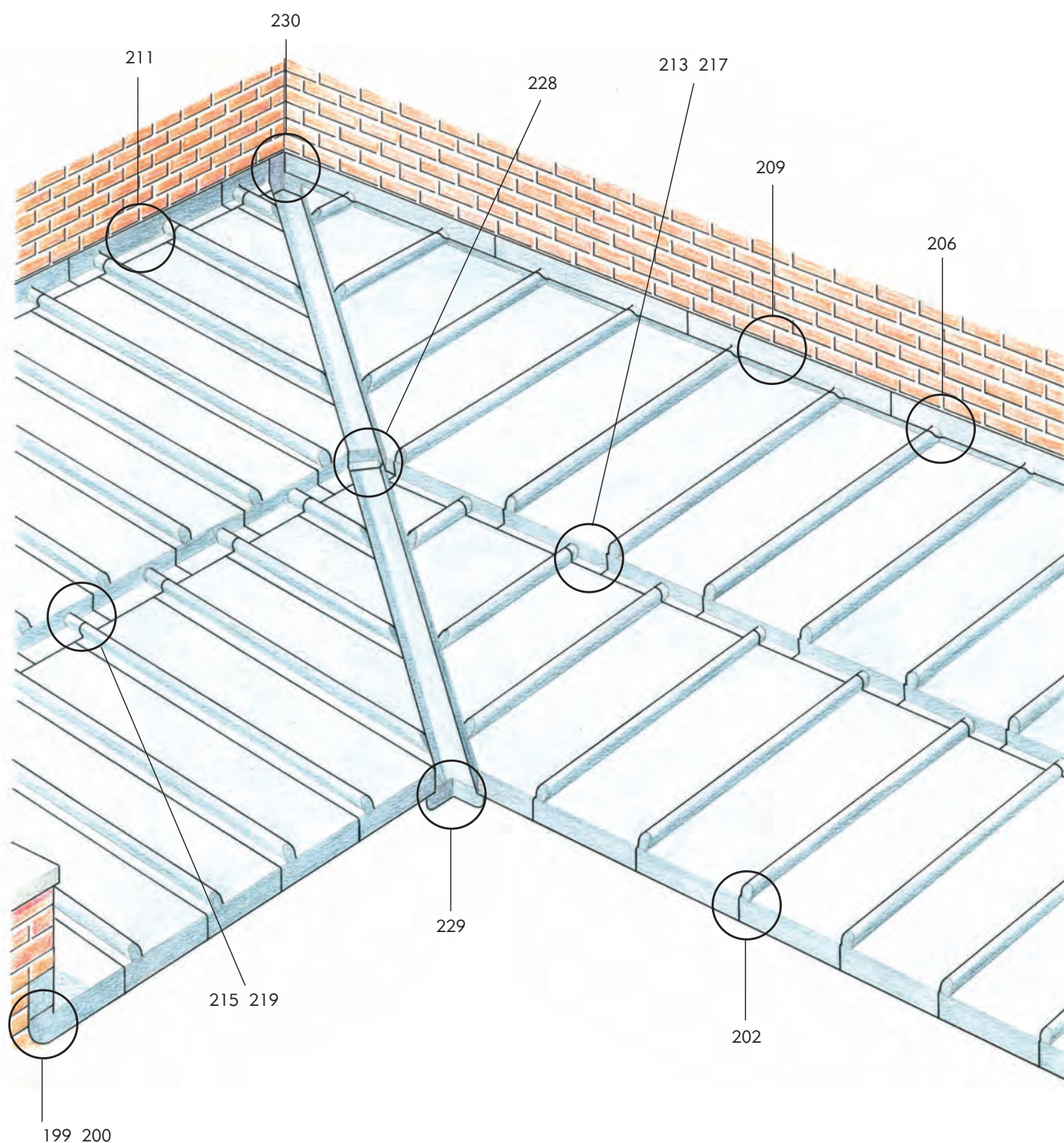


Fig 191 is an illustration showing the most common details associated with flat and low-pitched roofs. The annotations indicate the figure numbers in which the relevant detail is described and illustrated.

Flat roof coverings (cont.)

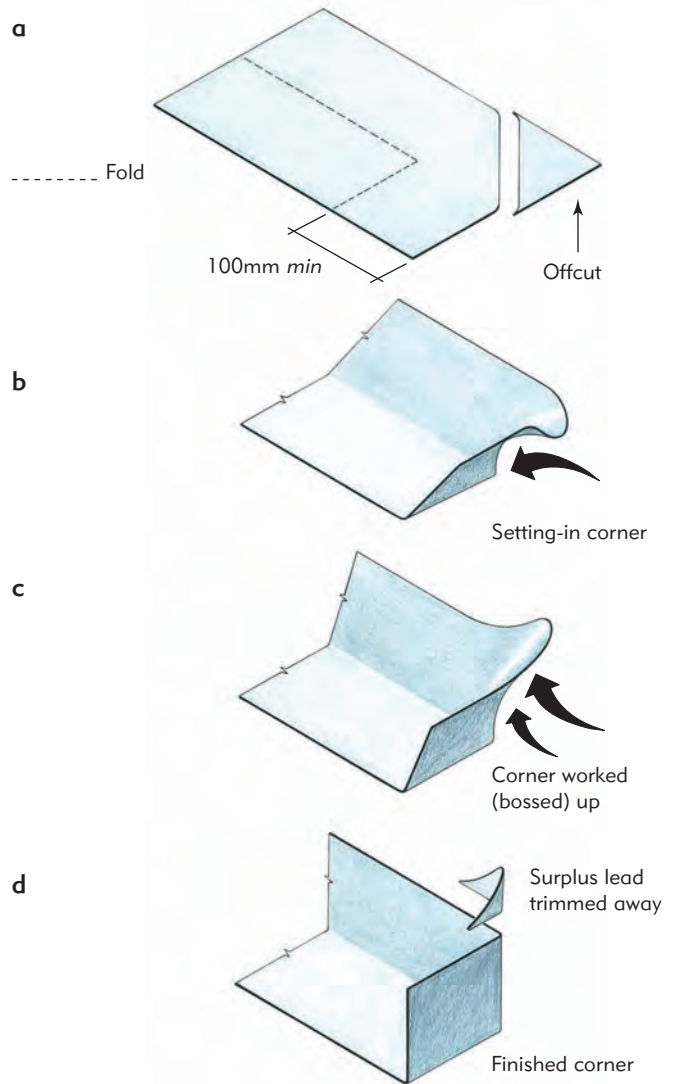
Leadwork details

The main leadwork details that arise with flat and low-pitched roofing are at abutments with adjoining walls, at external and internal angles, where rolls terminate at eaves, and at roll/drip intersections. Ridges, hips and valleys also occur on these roofs and often create complex intersections between joints. As far as possible, preparatory work should be done on the bench and should include the use of lead-welding in preference to bossing where there is a risk of thinning the lead – for example, when forming a break corner.

Bossed internal corner

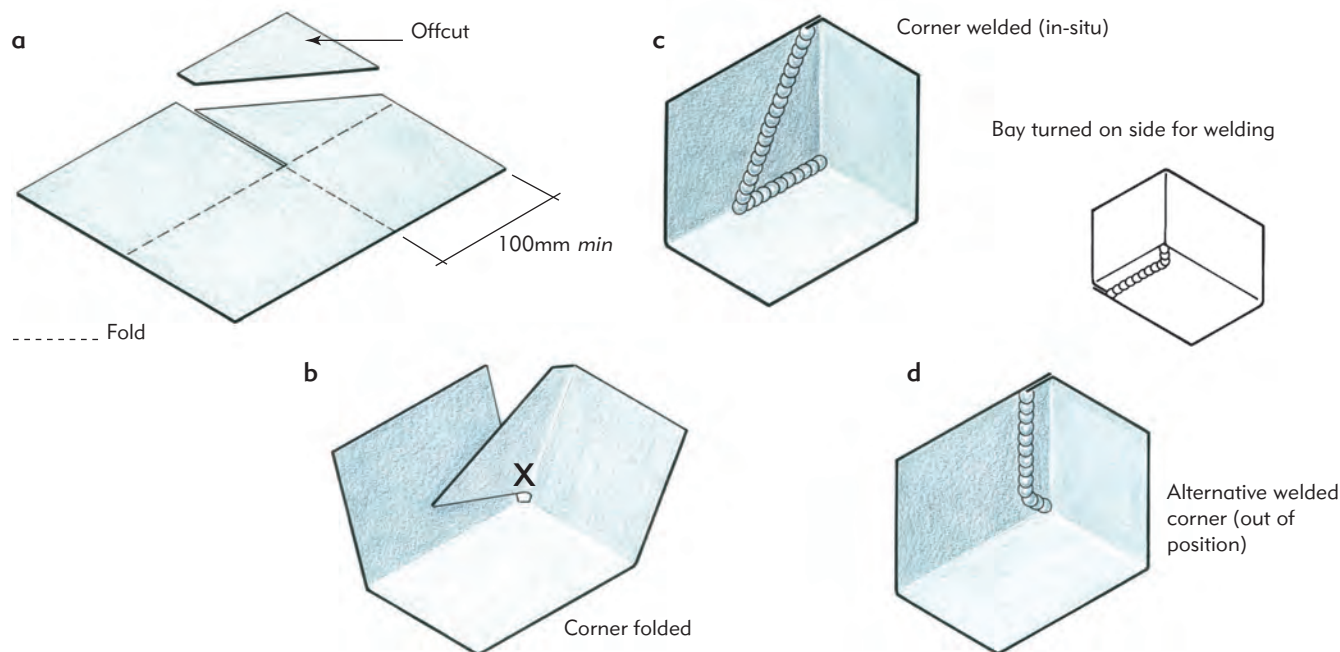
The main stages in bossing a corner are shown in Fig 192, the example being a corner for a flat roof covering. Folding lines are set in with a setting-in stick or dresser and the surplus lead is cut off (Fig 192a). The sides are partly pulled up and the corner is set in by directing a few blows downwards with a bossing stick to form the base of the corner (Fig 192b). The corner is then worked up, a mallet being held on the inside of the angle and the blows from the bossing stick directed from the base of the corner, in order to drift (boss) the lead up progressively to the top of the corner (Fig 192c). Surplus lead forms as the bossing proceeds and this is trimmed off when the required shape and angle of the corner has been reached (Fig 192d). The surplus is greatest for a corner to a flat roof and progressively decreases as the angle between the roof covering and wall increases.

Fig 192. Bossed internal corner



Flat roof coverings (cont.)

Fig 193. Lead-welded corner



Lead-welded corner

To weld a corner for a flat roof covering the sheet is set out and cut as shown in Fig 193a. If the corner is to be welded in-situ, the upstands are folded with the part marked X to the inside (Fig 193b), and then welded with angle and inclined seams (Fig 193c). In most cases, however, the corner can be formed on the bench and the bay turned on its side and welded using a flat lapped seam (Fig 193d).

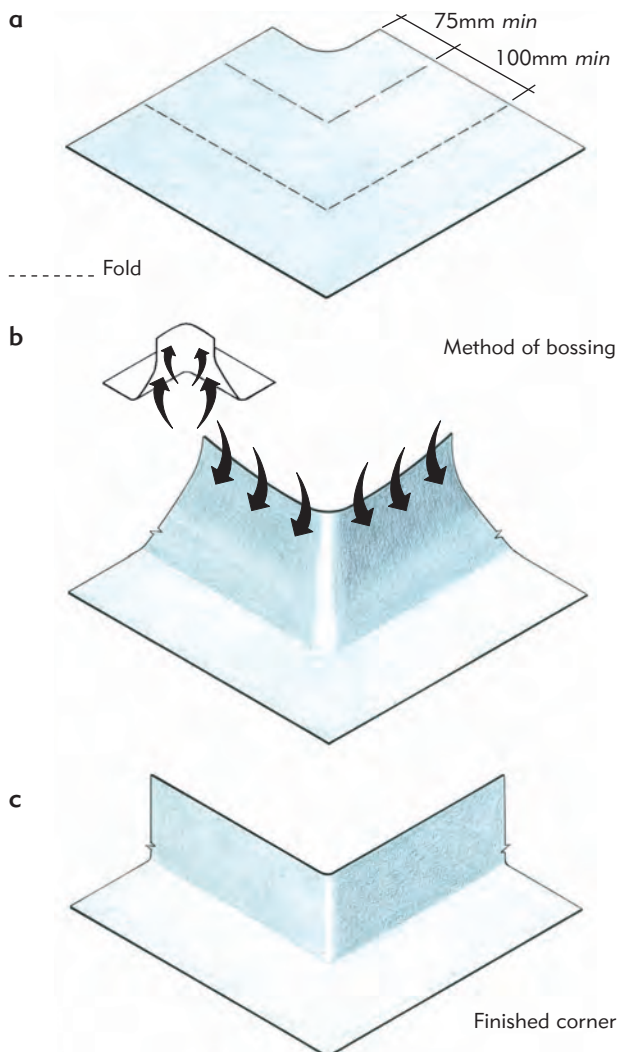
Bossed break (external) corner

Bossing a break corner for a flat or low-pitched roof is very labour-intensive and there is a risk of thinning the lead unduly at the corner. Although guidance on bossing is given here, it should be noted that a break formed by lead-welding is usually preferable and more economical in both labour and material.

When bossing the corner, extra lead is required to form the angle and at least 75mm is added to the upstand for this purpose (Fig 194a). After setting in the fold lines, the sides are pulled up as far as possible without stretching the lead and then bossed from both sides in the directions indicated in Fig 194b.

The bossing allowance is gradually driven towards the corner so that, when finished, the thickness of lead at the angle is approximately the same as that for the lead being used for the work. When the break corner has been fully bossed to the angle required, the surplus lead is trimmed off (Fig 194c).

Fig 194. Bossed break (external) corner



Flat roof coverings (cont.)

Lead-welded break corner

Lead-welding a break corner is relatively easy when compared with bossing. The lead sheet is set out and cut as in Fig 195a – the gusset shown being suitable for a flat roof. For pitched roofs, the shape of the gusset will vary with the pitch and the most practical way of obtaining the shape is to mark the gusset with the bay in position. The sides are turned up, the gusset folded and then welded in, using an inclined lap seam if the work is done in-situ or a flat lapped seam if working on the bench (Figs 195b and c).

Bossed drip abutting a wall

The undercloak is set out as in Fig 196a. Before the bay is positioned, the corner is bossed up (as previously described) to the height of the drip. In this case, the surplus lead is not cut off because it is required for the upstand against the wall. The bay is placed in position and the lead is then bossed down (Fig 196b). A driving plate is usually placed between the upstand and wall to avoid damage to the lead during bossing. After final dressing into position, the lead is trimmed (Fig 196c).

Bossing of the overcloak is usually done with the bay in position. The lead is set out as in Fig 196d, folded over the drip and then the upstand is bossed down (Fig 196e). Again, a driving plate is used to prevent damage and to allow the lead to move freely towards the corner. A driving plate is also placed under the splash lap to facilitate final working of the lead into the corner. Note the curved top edge of the finished upstand (Fig 196f). This indicates that the overcloak has been bossed correctly to provide a corner that is not unduly thinned. Fig 196g shows the completed drip abutment with cover flashings in position.

Fig 195. Lead-welded break corner

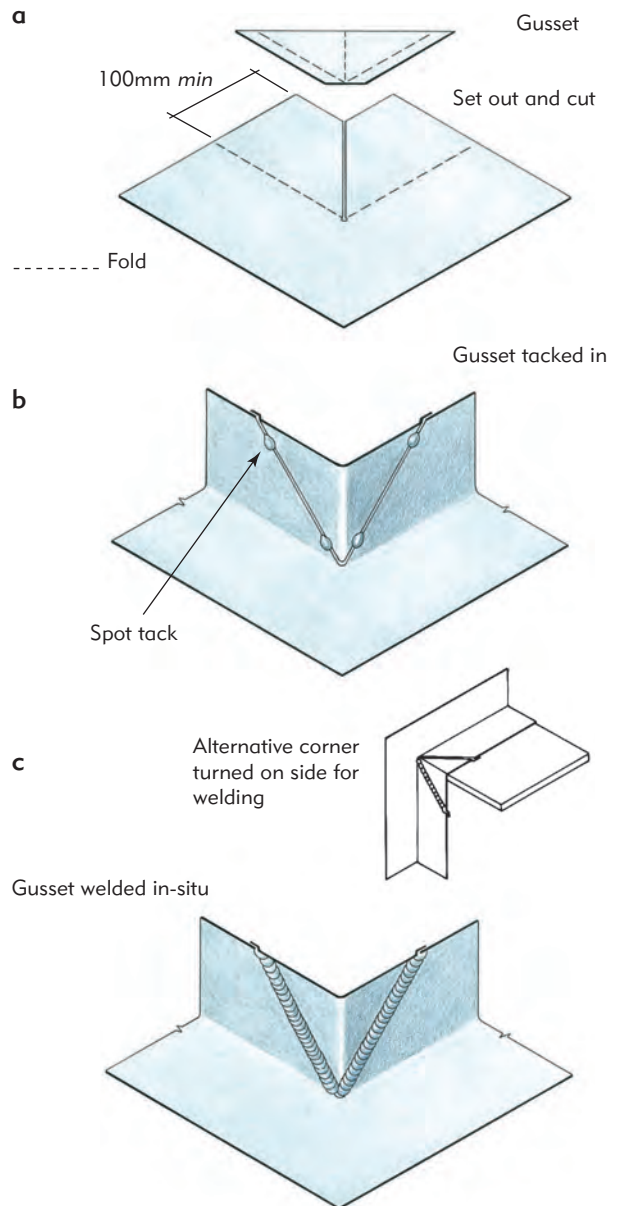
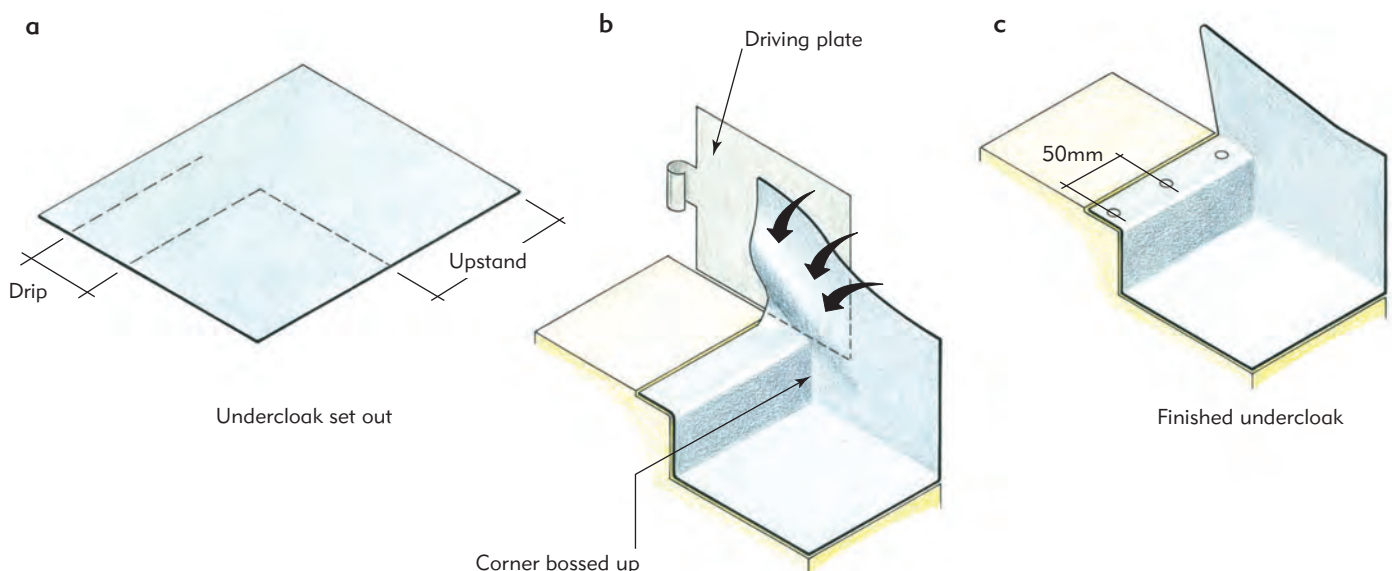
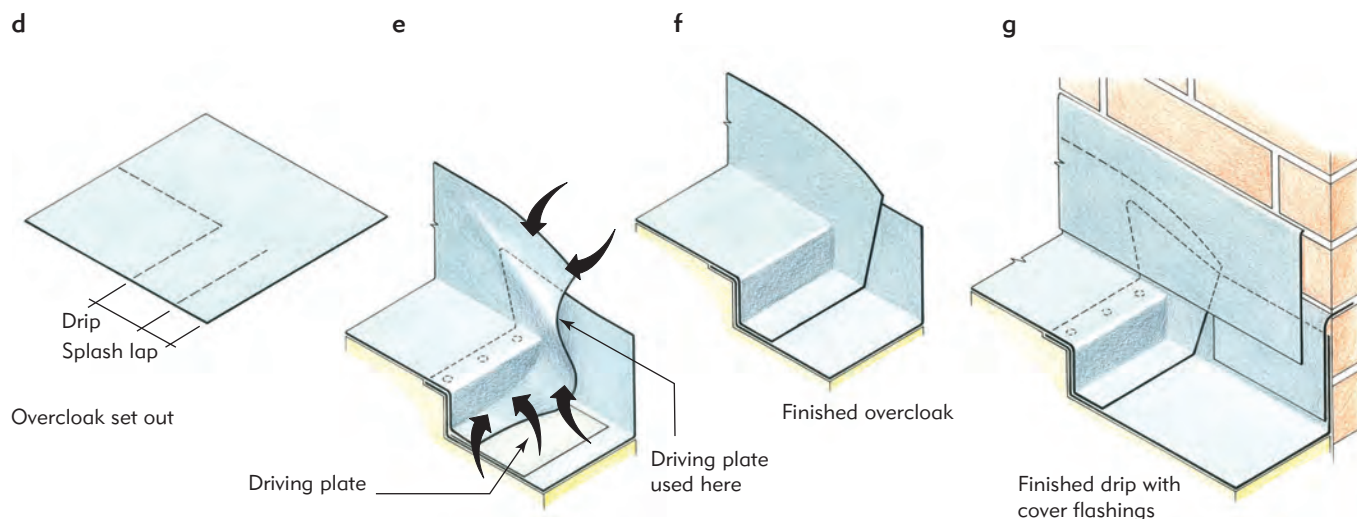


Fig 196. Bossed drip abutting a wall – undercloak



Flat roof coverings (cont.)

Fig 196. (cont.) Bossed drip abutting a wall – overcloak and flashing

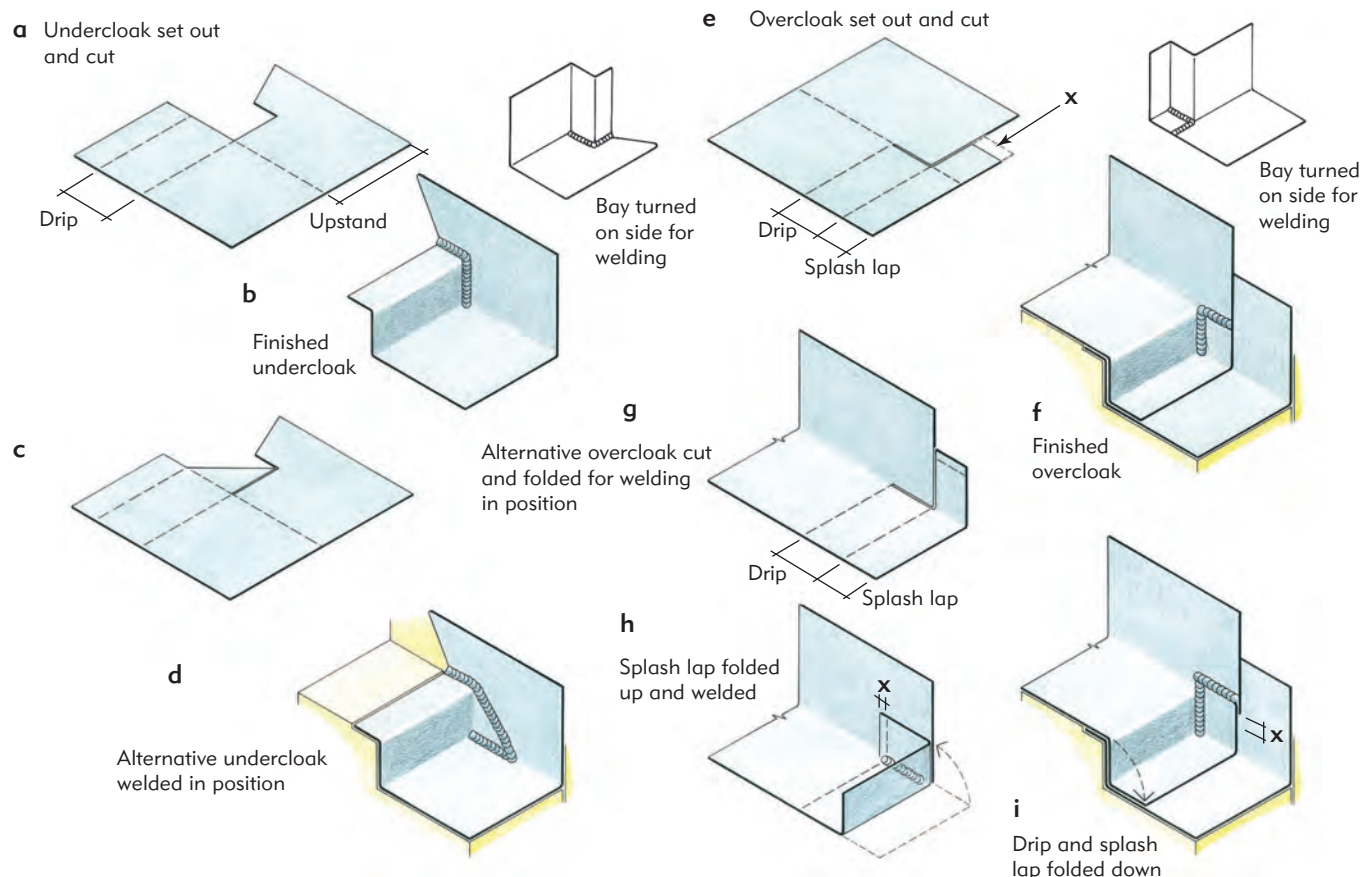


Lead-welded drip abutting a wall

In most cases, the welding required in forming this drip can be carried out prior to placing the bay in position. The undercloak is set out, cut as shown in Fig 197a, then folded and lead-welded with angle seams, with the bay turned on its side (Fig 197b). If welding in position cannot be avoided, the undercloak can be set out and cut as shown in Fig 197c, then folded and lead-welded with flat and inclined angle seams (Fig 197d).

The overcloak is set out, cut as in Fig 197e, then folded and lead-welded using angled and flat butted seams, with the bay turned on its side (Fig 197f). When welding in position, the overcloak is cut and folded, as Fig 197g, then turned and welded with an angle seam (Fig 197h). Finally, the overcloak is turned down and the allowance marked X used to facilitate the welding of an overhand horizontal seam (Fig 197i).

Fig 197. Lead-welded drip abutting a wall



Flat roof coverings (cont.)

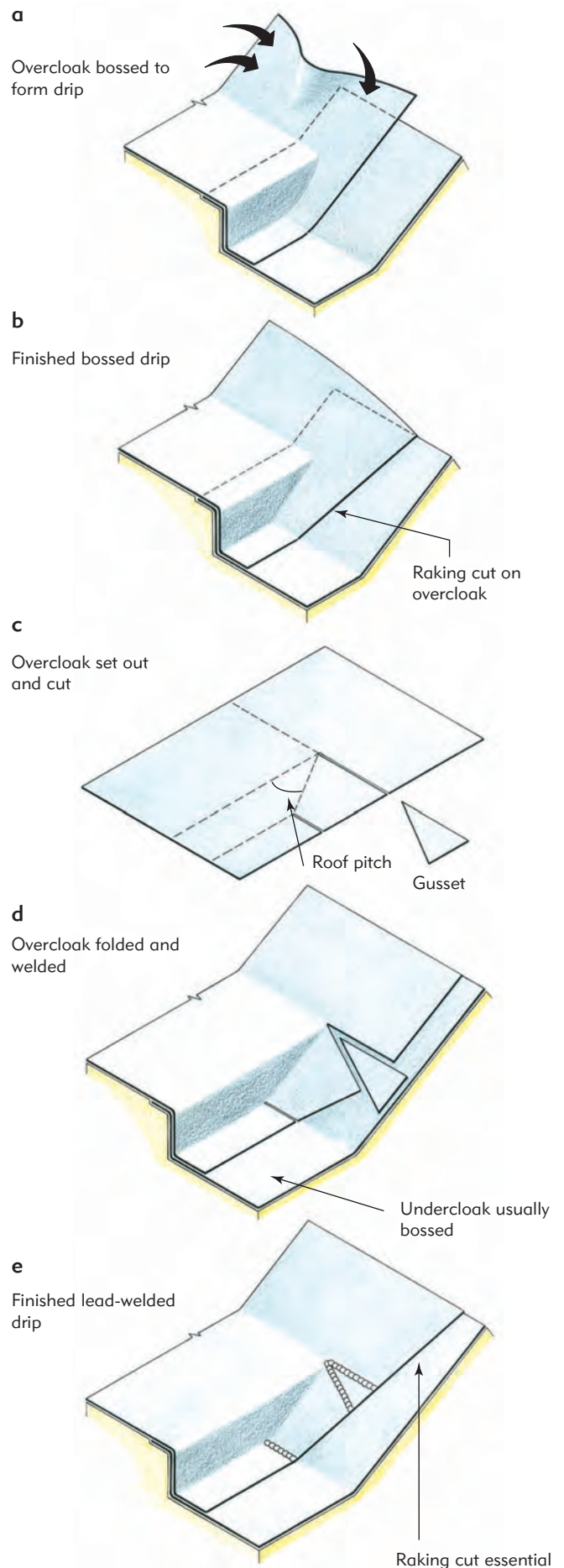
Drip abutting a slope

Normally, this drip is formed by bossing. It is a relatively simple operation, using the technique previously described for Fig 196. The shallower the slope, the easier it is to form the drip. In bossing the overcloak, the lead is worked round as shown in Fig 198a, thereby providing the raking cut necessary to give effective weathering at the slope (Fig 198b).

Although this drip can be formed by lead-welding, usually the undercloak would be bossed. The overcloak is set out and cut as in Fig 198c. After folding into position, a gusset is inserted and welded using a horizontal lapped joint, if being welded in position, or a flat butt joint if the bay can be moved and turned on its side (Fig 198d). Again, the overcloak at the side of the drip must be cut on the rake as shown in Fig 198e, and this is particularly important when the sloping roof is covered with slates or tiles.



Fig 198. Drip abutting a slope



Flat roof coverings (cont.)

Eaves-to-wall abutments

These abutments occur where a wall continues past or stops at the eaves. When bossing this corner, the upstand is worked down with the bay either turned on its side or in-situ using a driving plate (Fig 199a). The finished corner is weathered with a cover flashing (Fig 199b). Where the wall stops at the eaves, the lead can be turned round the corner of the brickwork (Fig 199c). When lead-welding is used instead of bossing, the lead is cut along the fold line to the intersection and a gusset inserted and welded in (Figs 200a and b). When lead-welding is used instead of bossing, the lead is cut along the fold line to the intersection and a gusset inserted and welded in (Figs 200a and b).



Fig 199. Eaves-to-wall abutments – bossed

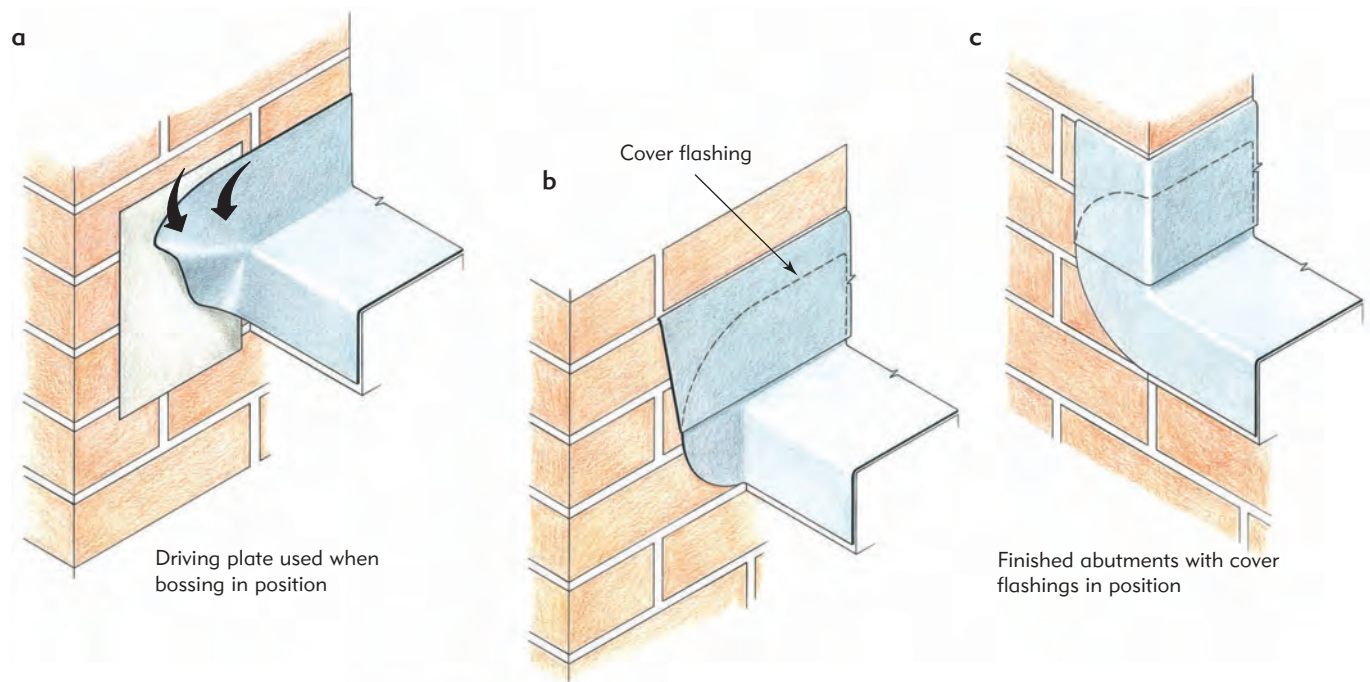
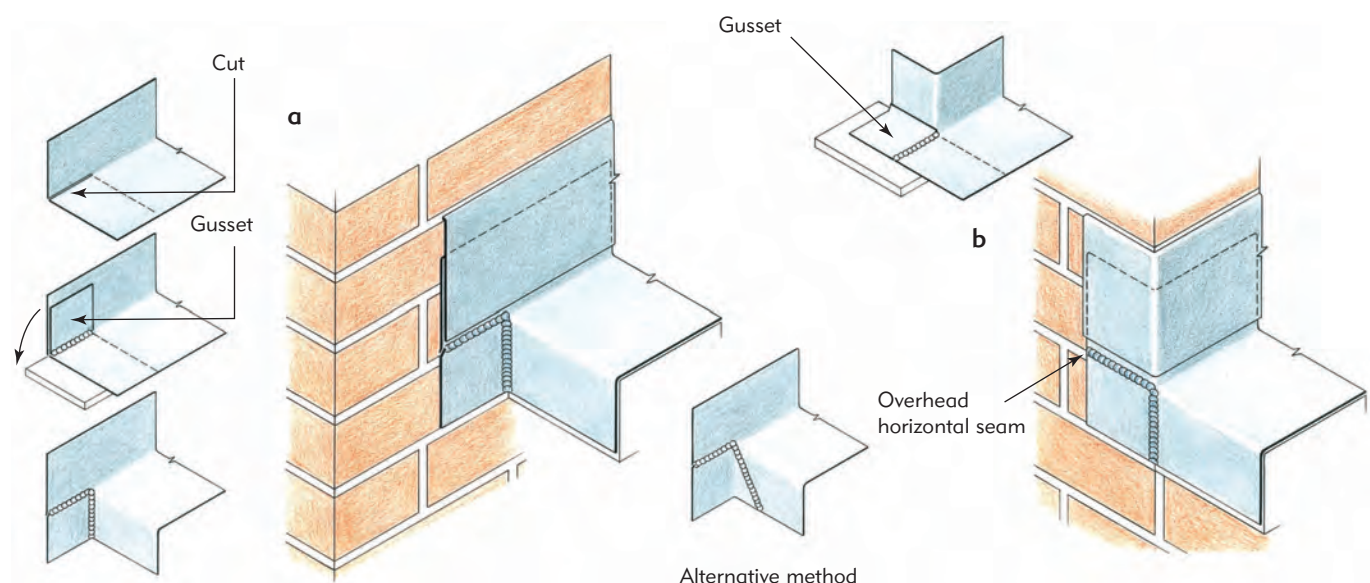


Fig 200. Eaves-to-wall abutments – lead-welded



Flat roof coverings (cont.)

Bossed wood-cored roll ends

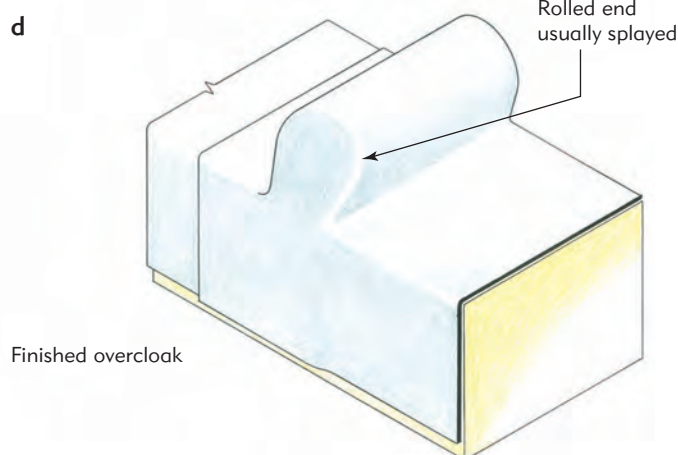
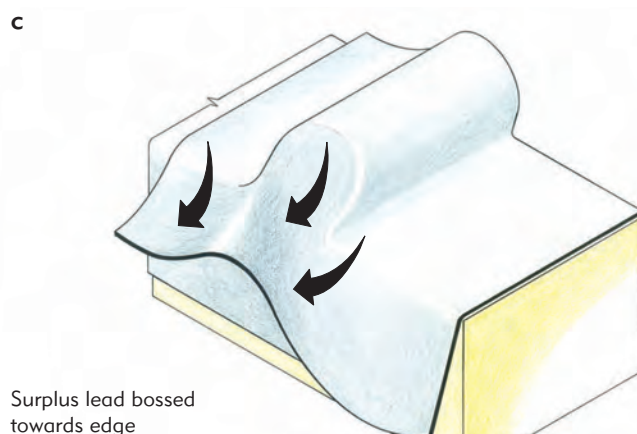
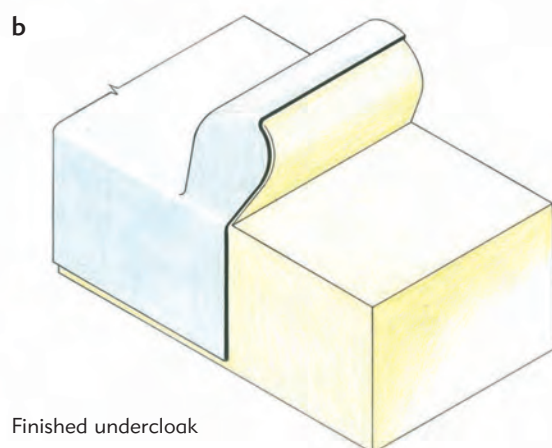
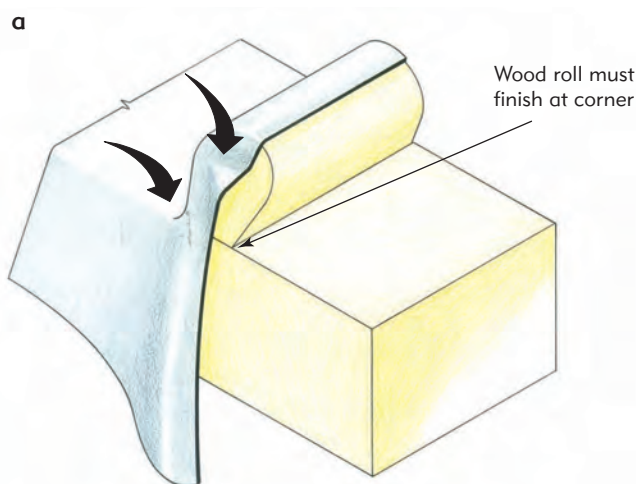
It is important that wood rolls are carried right to the edge of the eaves or drip to ensure that there is no flat lap joint in front of the finished roll end. To make bossing easier, the ends of wood rolls are normally splayed rather than cut off square.

Bossing is done with the bay in position, allowing not less than 75mm for the lead to be turned down. In shaping the undercloak, the first few blows with the bossing stick or mallet are directed towards the top of the roll to set in the lead and to avoid the risk of thinning as bossing proceeds. With a short-handled dummy or mallet held under the lead, the surplus is bossed in the direction of the arrows (Fig 201a) and then trimmed and dressed to fit the roll end (Fig 201b). When trimming the surplus lead from the undercloak, sometimes a tack is left on the bottom edge, which is subsequently turned over the overcloak.

For an overcloak that incorporates a splash lap, the roll end is bossed in basically the same way as for the undercloak but more bossing is needed because the lead has to fit a corner on each side of the roll end (Figs 201c and d).



Fig 201. Bossed wood-cored roll end



Flat roof coverings (cont.)

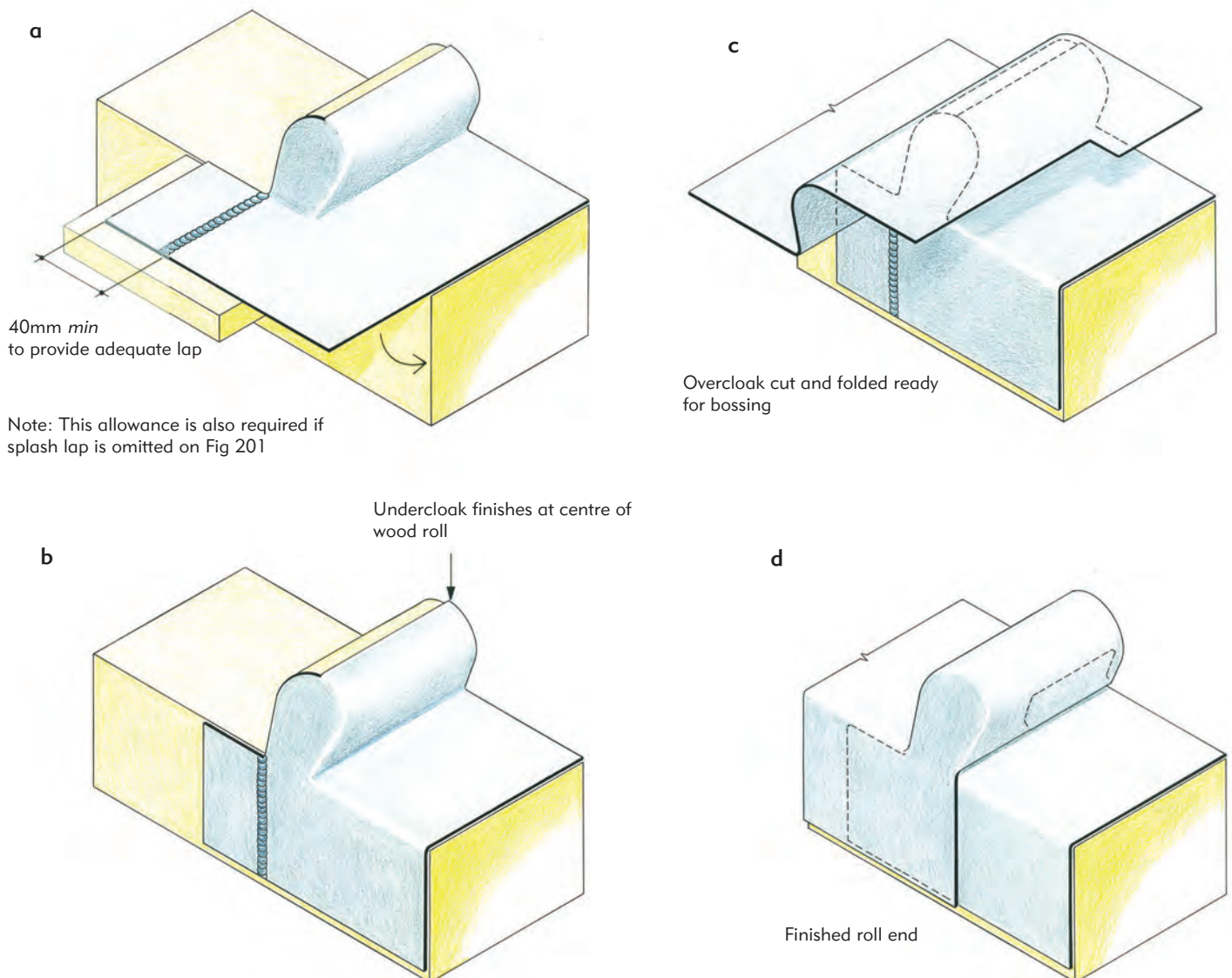
Bossed wood-cored roll ends (alternative detail)

When using the alternative roll detail where the overcloak is turned to engage copper clips, or where the splash lap is omitted, the undercloak is bossed as already described, but an additional allowance is required to provide an adequate lap on the downstand. Although an extra 40mm could be added to the undercloak, it is more practical and economical to weld in an extra piece of lead (Fig 202a). The lead can be turned down after the supported flat butt joint has been welded (Fig 202b).

To simplify the bossing of the overcloak, the welted edge is cut away, as shown in Fig 202c, and then the roll end is bossed as before and finished (Fig 202d).



Fig 202. Bossed wood-cored roll end – alternative detail (see Fig 59, page 36)



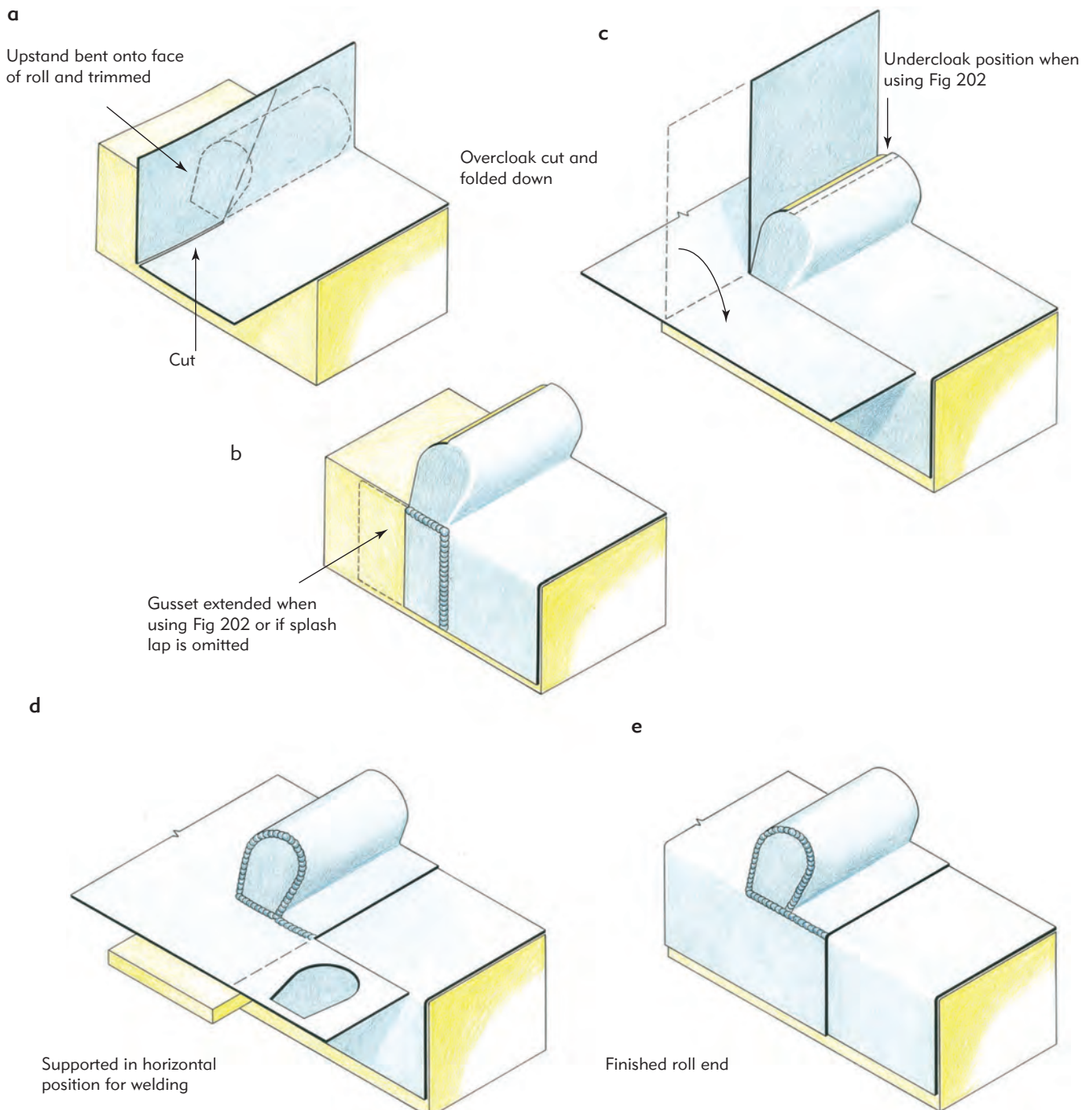
Flat roof coverings (cont.)

Lead-welded wood-cored roll ends

For the undercloak, the lead is first cut as shown in Fig 203a. The upstand is then bent and dressed onto the face of the roll and trimmed to the shape of the roll end. A gusset is fitted and, with the work supported in the horizontal position, is welded using flat lapped and angle seams and then dressed down (Fig 203b).

In forming the overcloak, the lead is cut and left horizontal ready for lead-welding (Fig 203c). After folding the upstand over the roll, an end piece is cut and fitted and then welded using flat butted, angle and inclined seams (Fig 203d). The completed lead-welded roll end is shown in Fig 203e.

Fig 203. Lead-welded wood-cored roll end



Flat roof coverings (cont.)

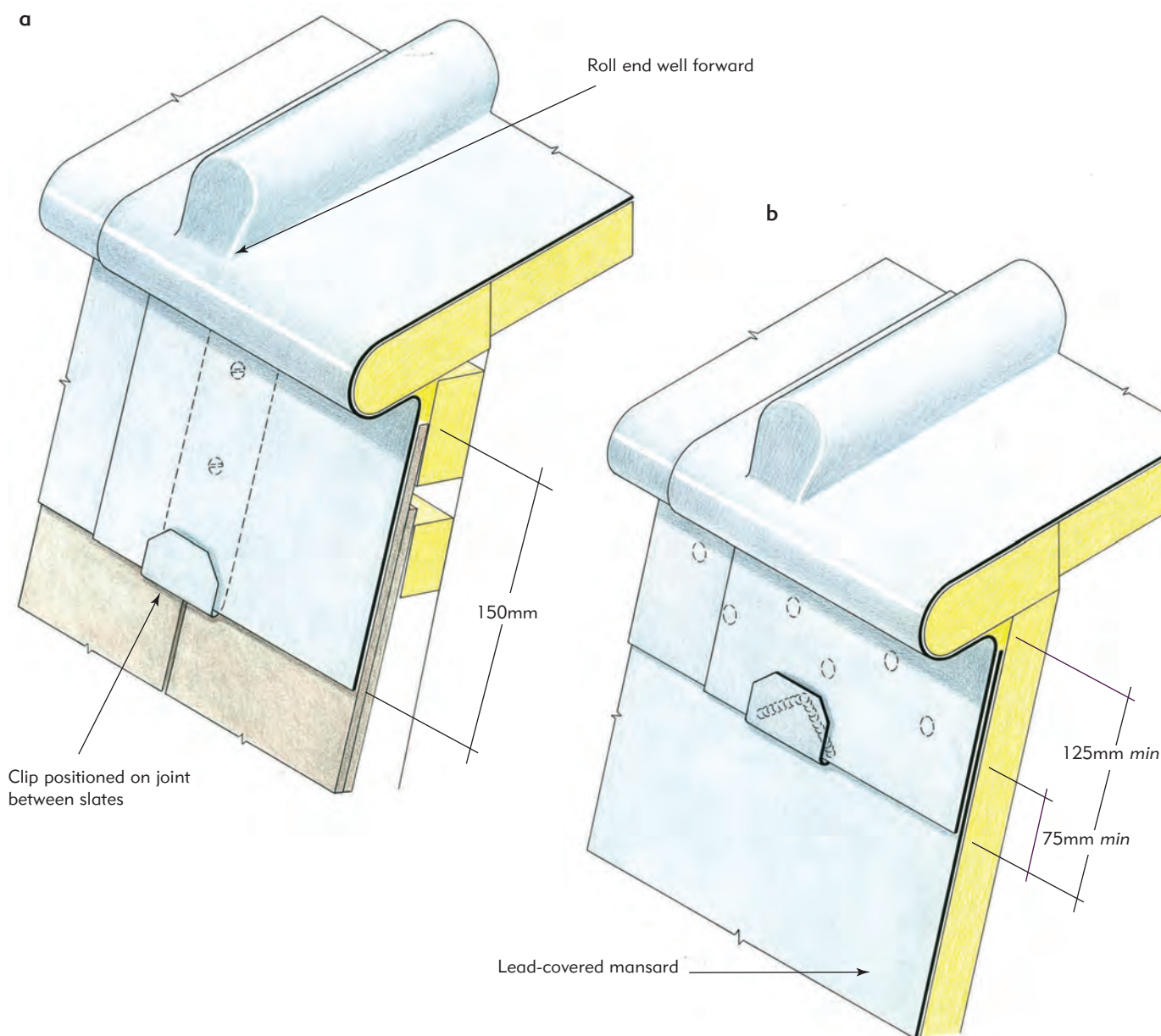
Roll end/torus roll junction

Torus rolls are often used at the junction between a lead-covered flat roof and a mansard roof. Where a wood-cored roll finishes over a torus roll, the roll end is bossed or welded, as already described, but extra allowances are required for the turn-down. This will depend on the size of the torus roll and the materials used for covering the mansard slope.

Fig 204a shows a typical detail over a slated mansard. Where the extension down the mansard exceeds 150mm, a separate flashing is used with a minimum cover of 100mm (Fig 204b). This will occur if a deep ornamental flashing is used or where the mansard is covered with lead sheet, as shown.

Although the spacing and fixing of clips along the free edge of all leadwork is important, clips are particularly necessary below a torus roll because they also prevent the lead from sagging away from the underside of the roll.

Fig 204. Roll end/torus roll junction



Flat roof coverings (cont.)

Bossed wood-cored roll abutting a wall (up to 3°)

With roof pitches up to and including 3°, the roll abutting a wall upstand against the wall should not be less than 100mm. The undercloak and overcloak are turned up and the corners are roughly bossed up about 40mm before the bay is placed in position (Fig 205a). With the bay in position, the undercloak is dressed down to fit the roll, the surplus lead trimmed off and then nailed to the roll for the top third of the bay length (Fig 205b).

The overcloak is worked down towards the angle, with the necessary extra lead coming from the upstand. Driving plates are used to help the lead to move easily and to avoid damage to the overcloak (Fig 205c). Using a mallet and chase wedge, the lead is finally drifted into the angle and the splash lap is then trimmed, taking care not to cut into the undercloak (Fig 205d).

When using the alternative wood-cored roll detail (Fig 59, page 36), or when the splash lap is omitted, the overcloak is prepared as already described. After placing the bay in position, the upstand is bossed down using a driving plate (Fig 206a). The overcloak is trimmed and the upstand finished with a raking cut (Fig 206b).

Fig 205. Bossed wood-cored roll abutting a wall (up to 3°)

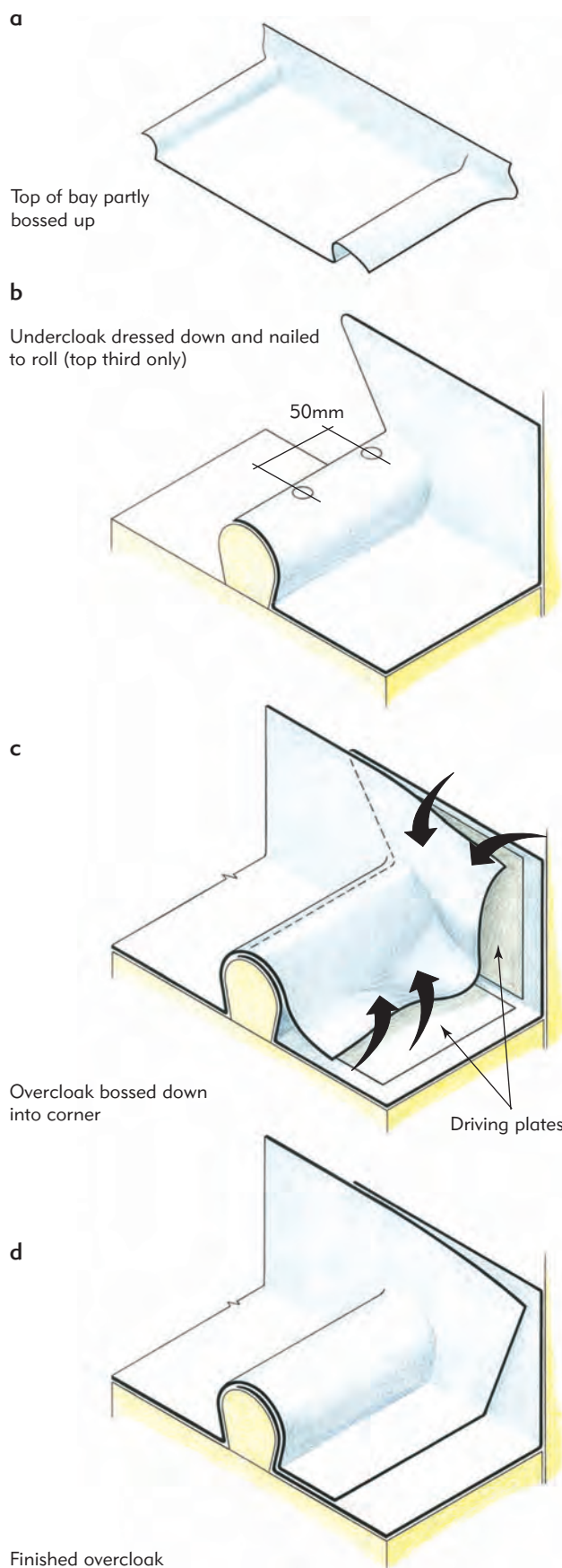
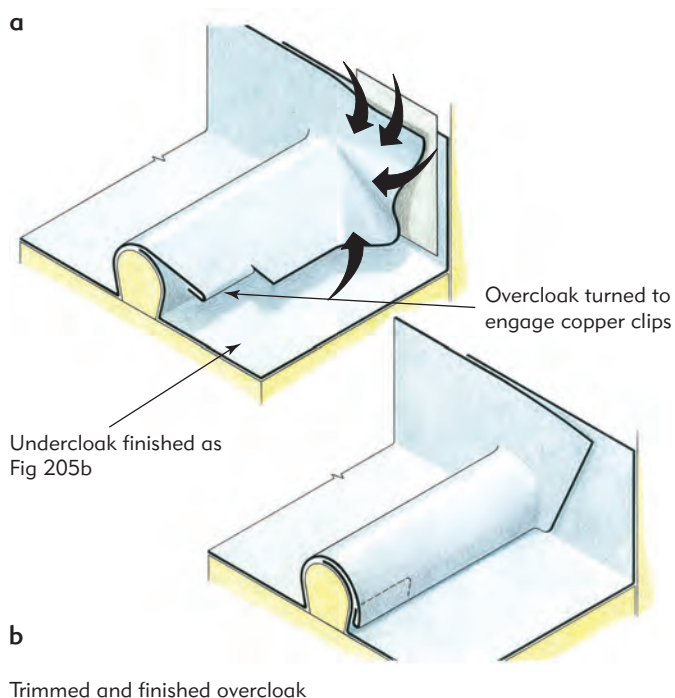


Fig 206. Alternative roll detail (up to 3°)



Flat roof coverings (cont.)

Lead-welded wood-cored roll abutting a wall

The undercloak and overcloak are set out and cut as shown in Figs 207a and b. The work is folded and the bay is then positioned on its end and lead-welded with angle seams (Figs 207c and d). If the work cannot be lifted up on end, the joint can be welded in position using upright and angle seams (Figs 207e and f).

With roof pitches above 3° up to and including 10°, it is necessary to provide fixings in the top of each bay. Since

a flashing will cover these fixings, the roll details at the abutment can be simplified. The bay is prepared as in Fig 208a, with the upstand against the wall not less than 50mm. With the bay in position, the undercloak and overcloak are dressed to fit the roll – Fig 208b shows the simplified overcloak detail and spacing of head fixings. It is not necessary to nail the top third of the undercloak to the roll.

Fig 207. Lead-welded wood-cored roll abutting a wall (up to 3°)

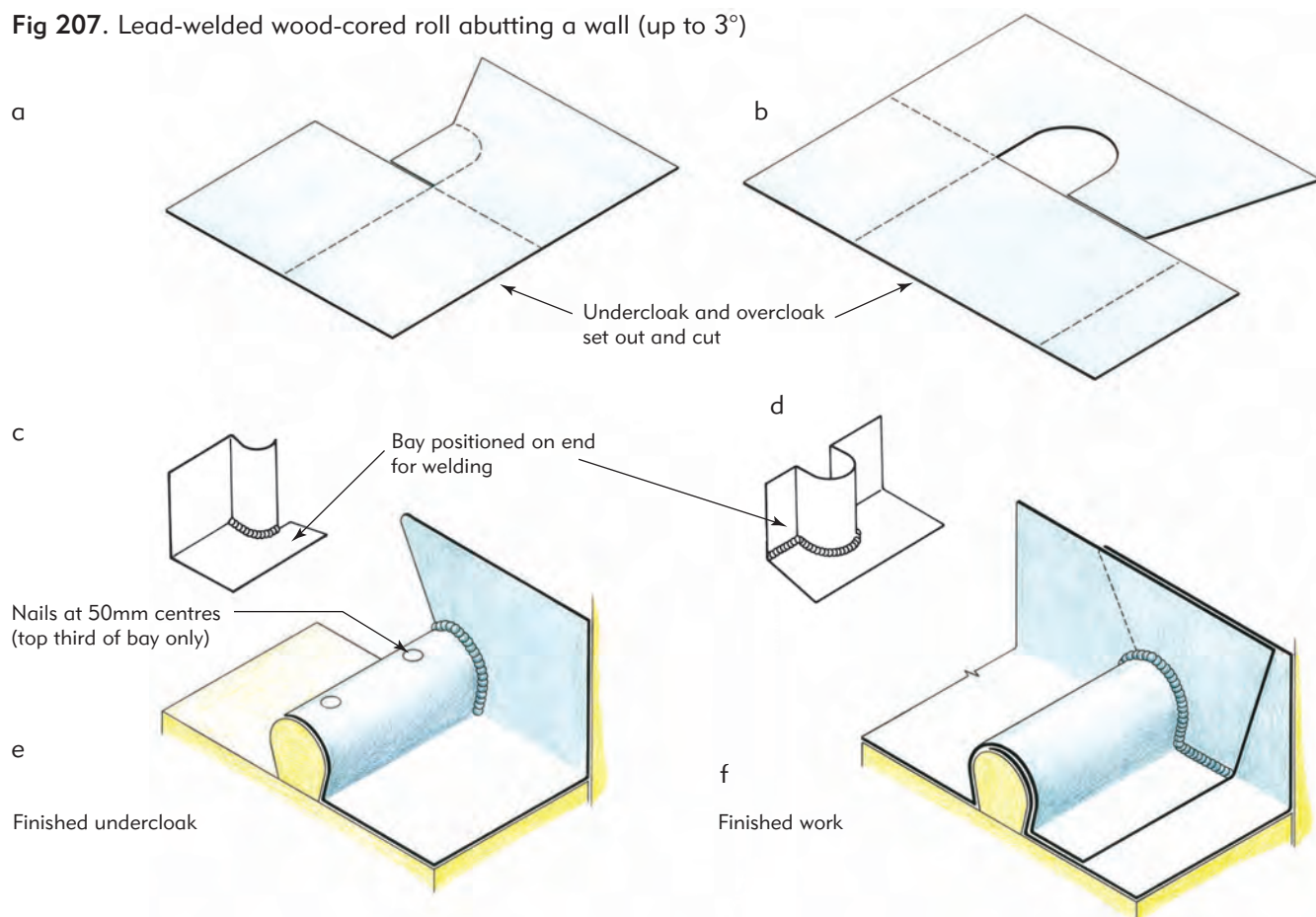
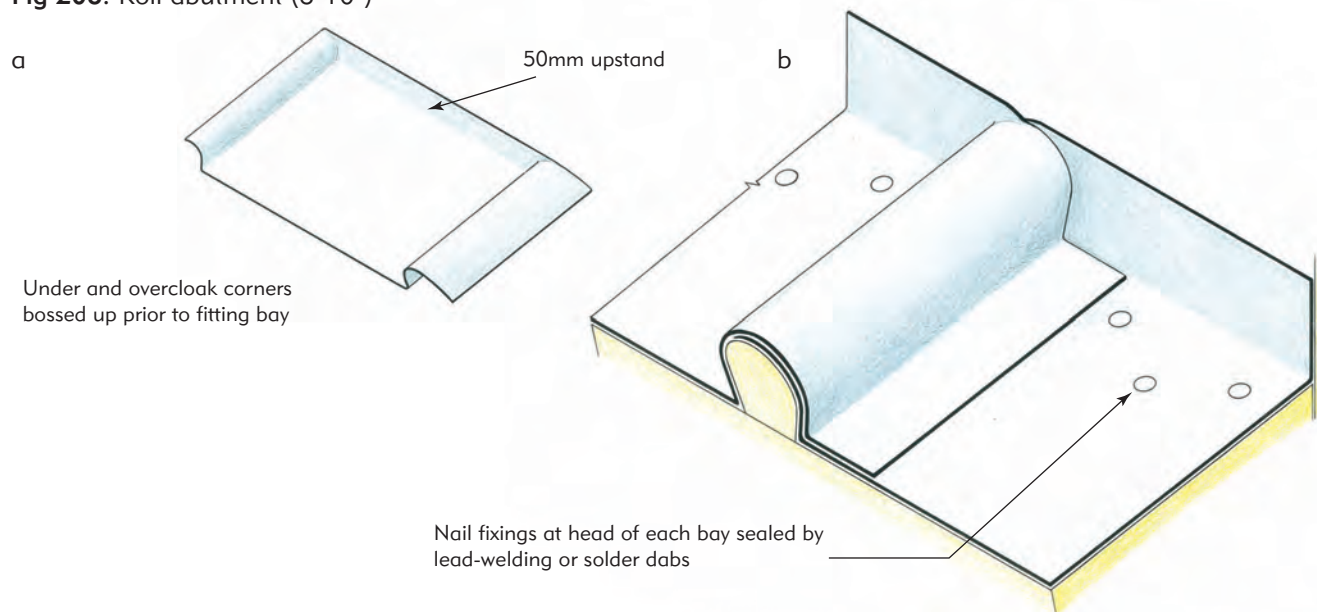
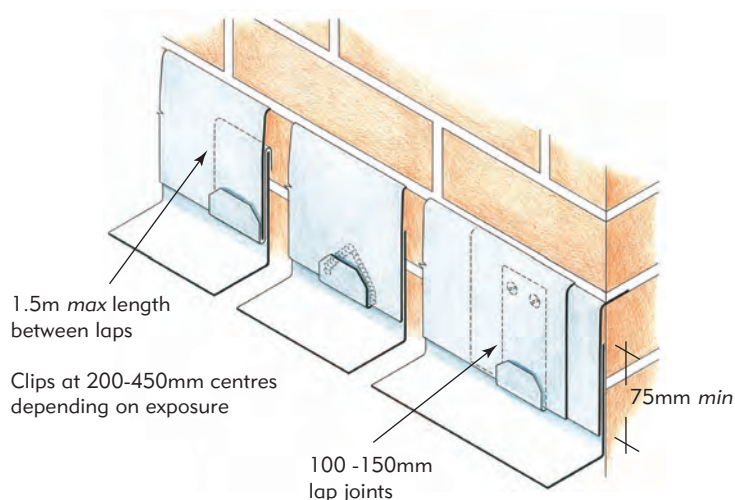


Fig 208. Roll abutment (3-10°)



Flat roof coverings (cont.)

Fig 209. Cover flashing (up to 3°)



Cover flashings at abutments (up to 3°)

The type of flashing used at a horizontal abutment depends on the roof pitch. For roof pitches up to and including 3°, the bay is turned up at least 100mm against the wall and the flashing covers this upstand by a minimum of 75mm. Individual pieces of cover flashing should not exceed 1.5m in length, with laps between pieces not less than 100mm. In severe exposures, the lap should be increased to 150mm. The top edge of the flashing is turned into a chase or groove in the masonry, of at least 25mm, and secured with lead wedges about 450mm apart. Clips are required along the lower edge at laps and at not more than 500mm centres (Fig 209). Three alternative clips are shown.

Where a roll abuts the wall, the flashing can be dressed over the roll, as in Fig 210, or cut to suit the roll shape. However, in both cases the cover over the upstand at the roll end must not be less than 50mm.

This type of cover flashing is also used to weather the upstands at abutments down the roof slope and is suitable for all pitches up to 10°. At drips, it is usually necessary to step the flashing (Fig 196g, page 114). Often, on the steeper pitches, similar extra steps are required between the drips.

Cover flashings at abutments (3-10°)

For roof pitches above 3°, up to and including 10°, the flashing is extended to cover the sealed fixings at the top of the roofing bays (Fig 211). Because this extension provides extra weathering, the upstand of the roofing bays can be reduced to not less than 50mm. Again, the flashing lengths must not exceed 1.5m with 100mm-minimum laps between pieces. Lead clips, welded to the roofing bays, should be spaced evenly along the free edge to suit the exposure.

Fig 210. Cover flashing at roll abutment

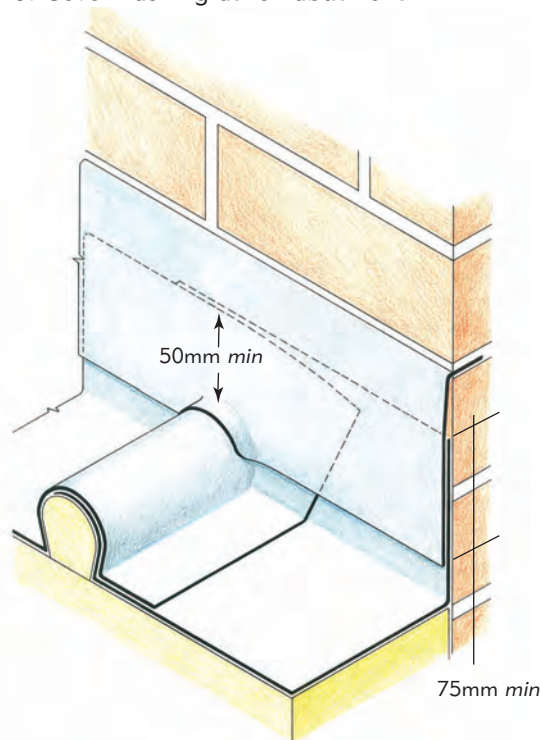
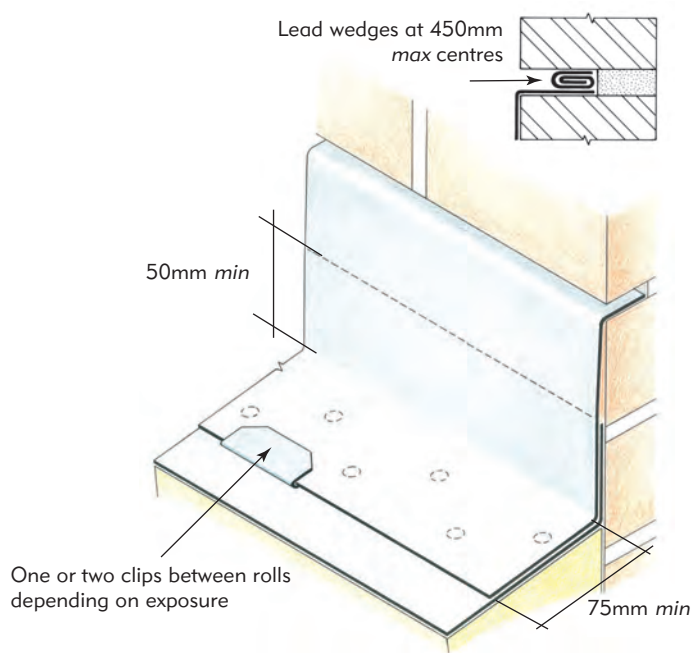


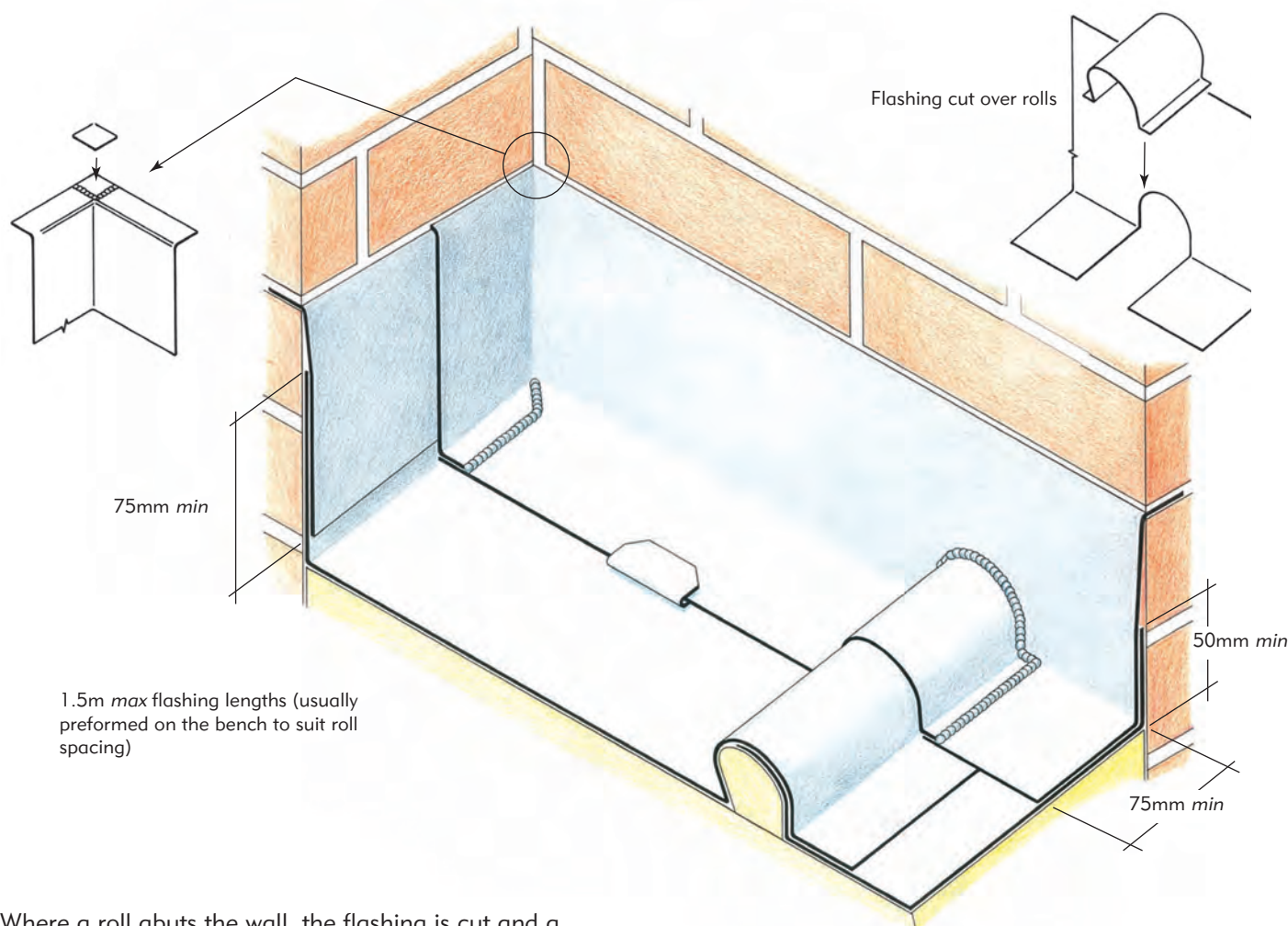
Fig 211. Cover flashings roof (3-10°)



Flat roof coverings (cont.)

Cover flashings at abutments (3-10°)

Fig 212. Cover flashing at roll end and corner abutment



Where a roll abuts the wall, the flashing is cut and a capping fitted and welded (Fig 212). These flashings are usually preformed to suit the roll centres. Laps between pieces are normally positioned in the centre of every second bay. At an internal corner, the flashing is cut to suit the roof pitch and welded with a lapped joint. Note the insertion of a square gusset at the corner of the turn-in to ensure a weather-tight joint at this vulnerable point.

Roll and drip intersections

Rolls on the upper and lower roof areas at a drip can be either staggered or fixed in line. In both cases, it is important that the finished height of the roll on the lower roof area is not less than 5mm below the top edge of the drip. To achieve this when using a standard 45mm-high roll, the drip height will vary according to the thickness of the lead sheet used. Table 11 shows the minimum drip height for codes 4 to 8. If larger wood cored rolls are used, the height of the drip should be increased to achieve the 5mm minimum between roll and drip heights.

Table 11. Flat roofs – drip heights

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

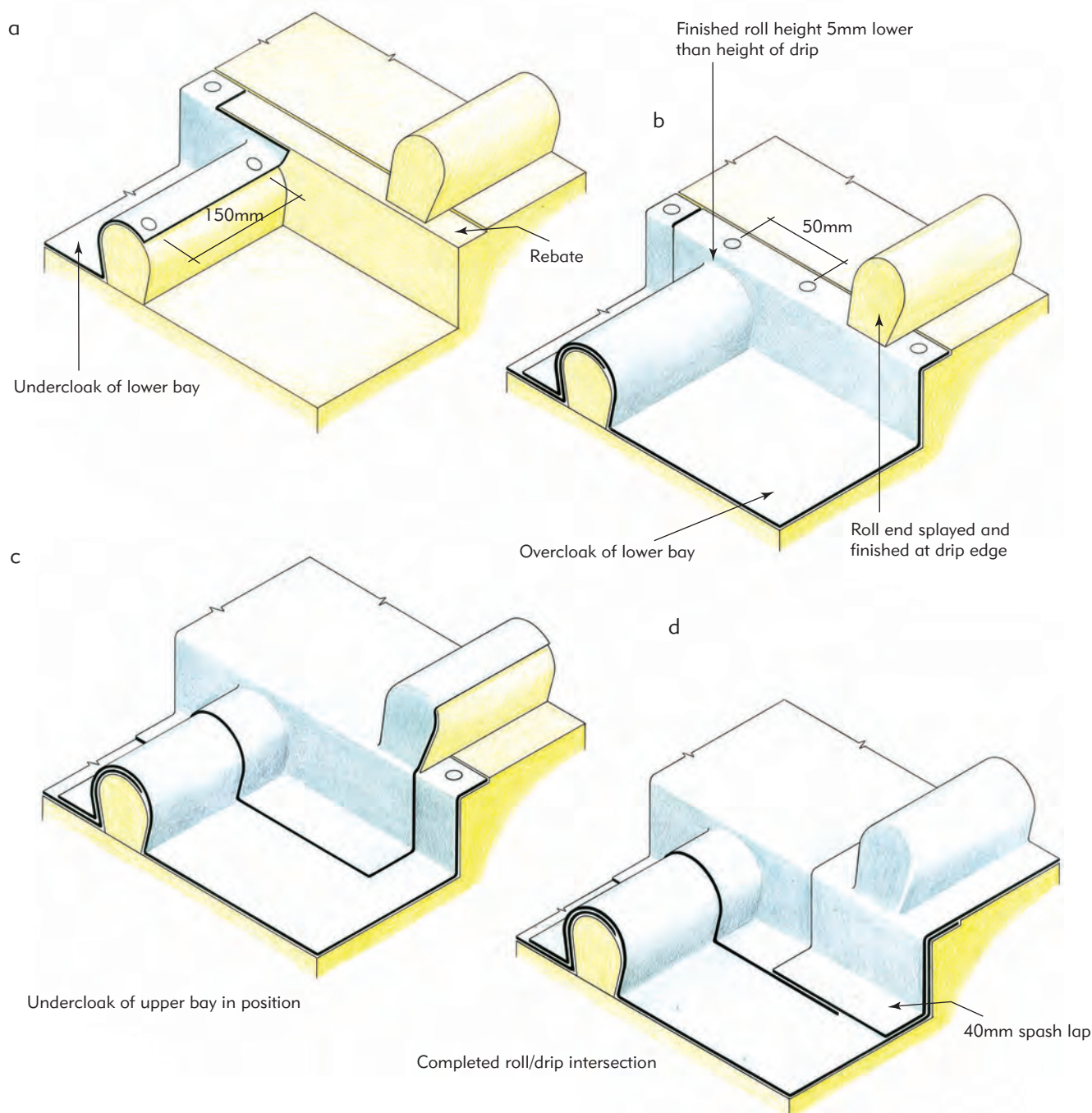
Flat roof coverings (cont.)

Roll and drip intersections (up to 3°)

Methods of forming bossed and lead-welded joints at roll/drip intersections are similar to 'Roll ends at eaves' and 'Abutments to walls' previously described.

Figs 213a, b, c and d show bossed details for pitches up to and including 3° where the rolls are staggered. Figs 214 a and b show similar details where the rolls are in line.

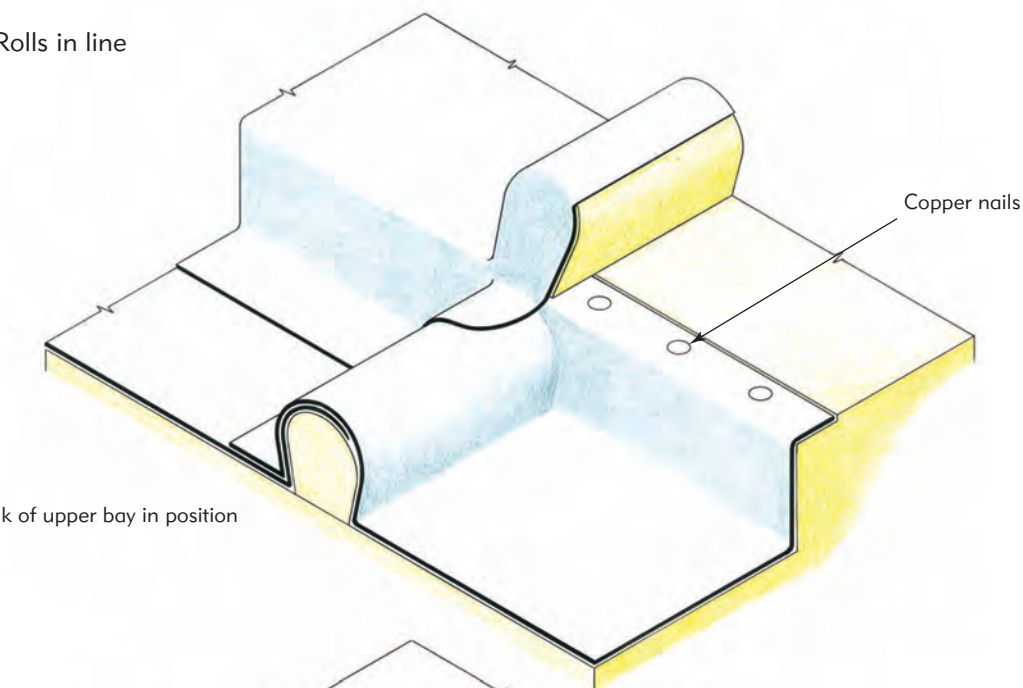
Fig 213. Staggered rolls (up to 3°) – bossed



Flat roof coverings (cont.)

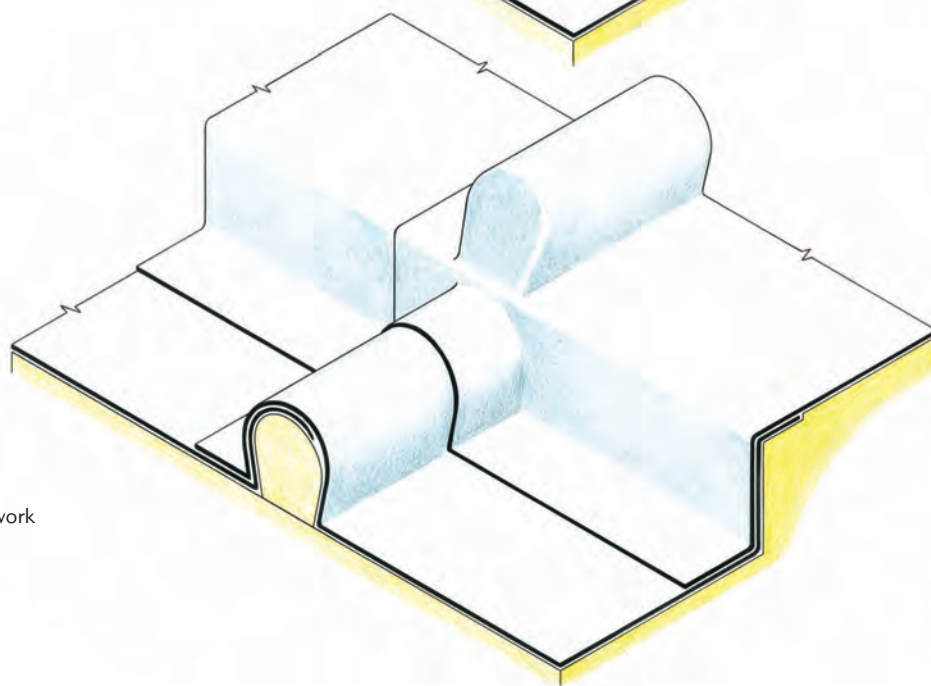
Fig 214. Rolls in line

a



Undercloak of upper bay in position

b



Completed work



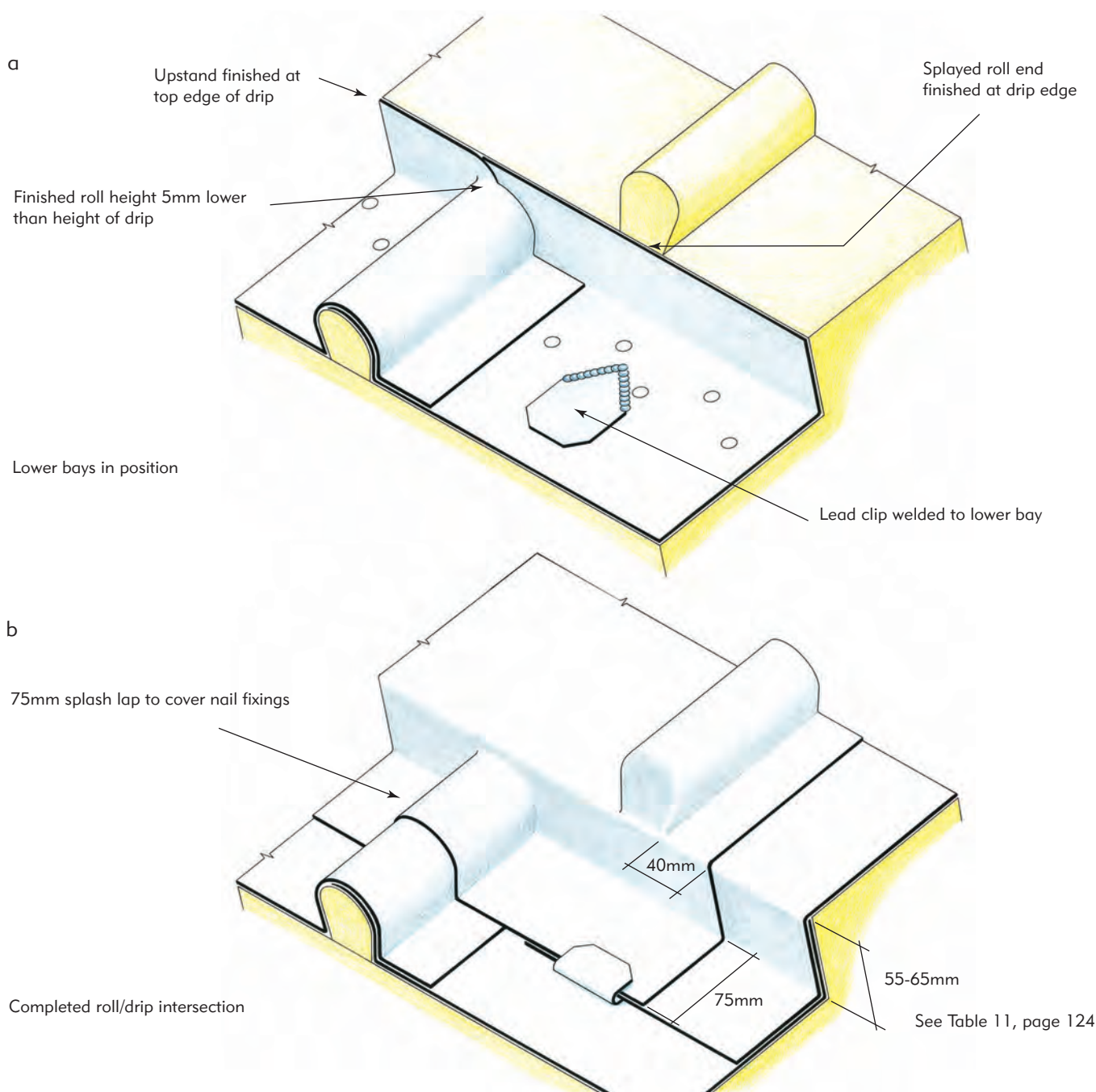
Flat roof coverings (cont.)

Roll and drip intersections (3-10°)

With lead-covered roofs pitched from 3° up to and including 10°, extra fixings are required to hold the bays firmly and permanently in position. As water will infiltrate the fixing area, it is necessary to seal the nail heads with solder or lead-welding. For aesthetic reasons, the fixing area is covered by extending the splash lap to at least 75mm.

Figs 215a and b show bossed details for roof pitches over 3°, with the rolls staggered, and Figs 216a and b show similar details where the rolls are in line. It is not necessary to fix the lead into a rebate in the front edge of the drip, but the upstand must be the full height of the drip, which will vary with the thickness of material used (see Table 11, page 124).

Fig 215. Staggered rolls (3-10°) – bossed



Flat roof coverings (cont.)

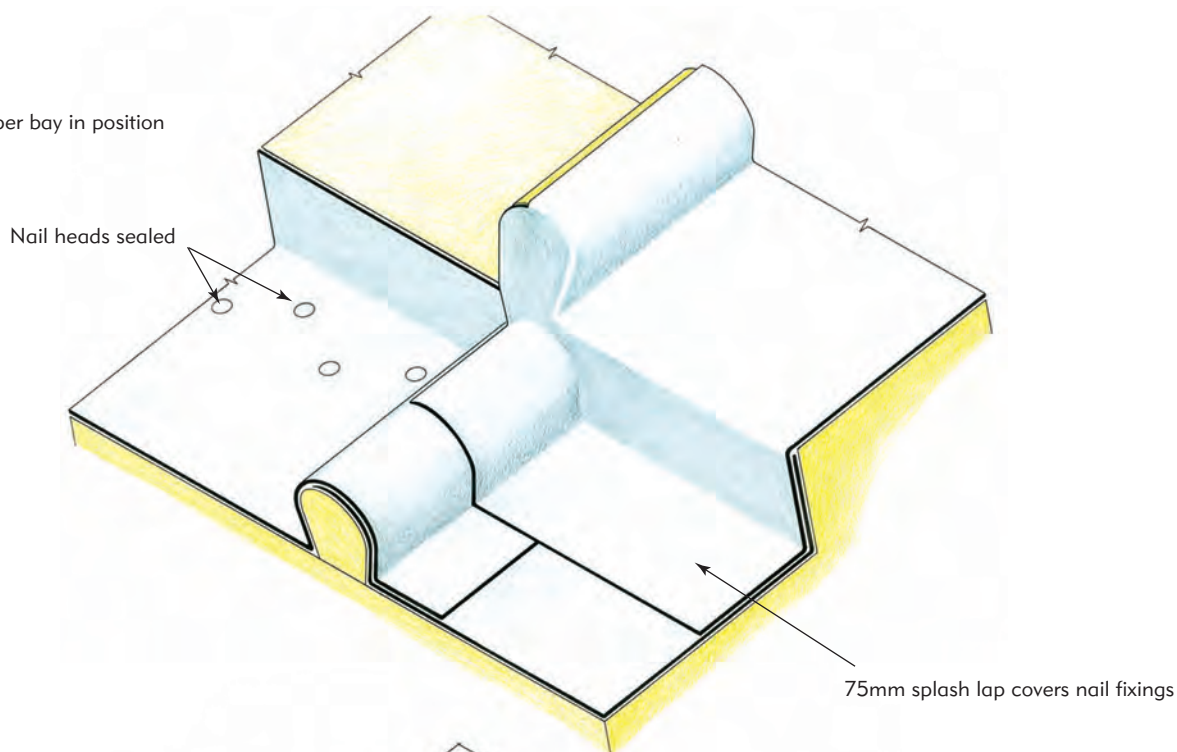
Roll and drip intersections (3-10°)

Bossed roll/drip intersections require care and skill to avoid undue thinning of the lead, particularly where the wide splash lap is bossed over the rolls. In many cases, the alternative lead-welded joints will be preferred, especially when the thinner codes of lead sheet are specified.

Fig 216. Rolls in line (3-10°) – bossed

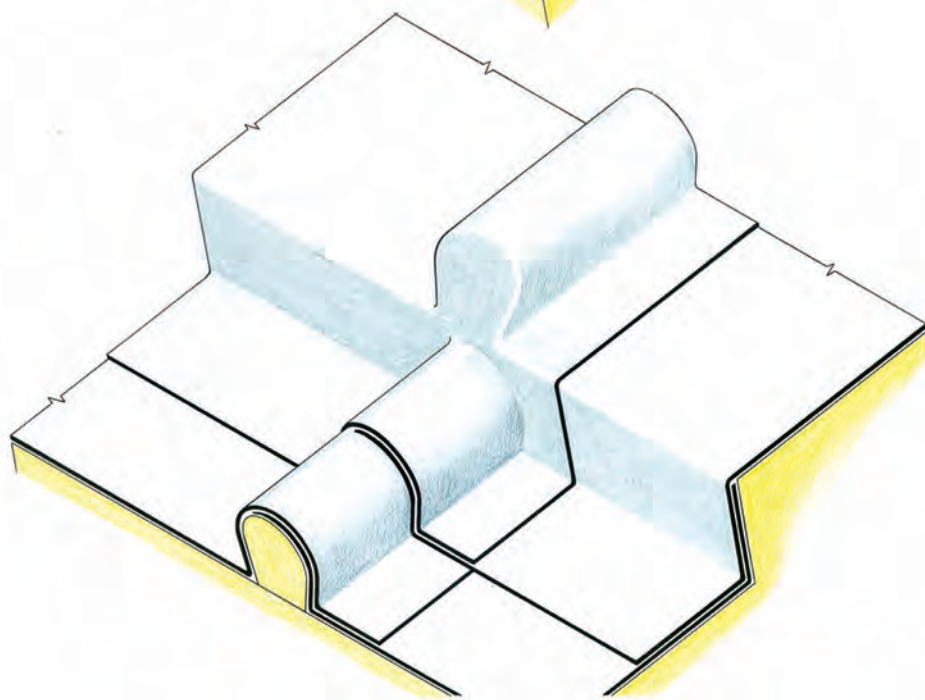
a

Undercloak of upper bay in position



b

Completed work



Flat roof coverings (cont.)

Roll and drip intersections (up to 3°)

When using lead-welding to form these intersections, the roll abutting the drip is as shown in Fig 207, except that the upstand is turned and nailed into the rebate. The roll end is formed as previously described (Fig 203, page 119) but, before turning the lead down, the extension is cut above the abutting roll and a cover piece welded on (Figs 217a and b).

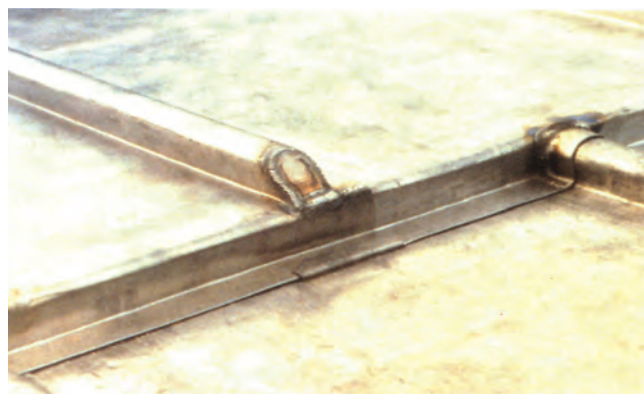
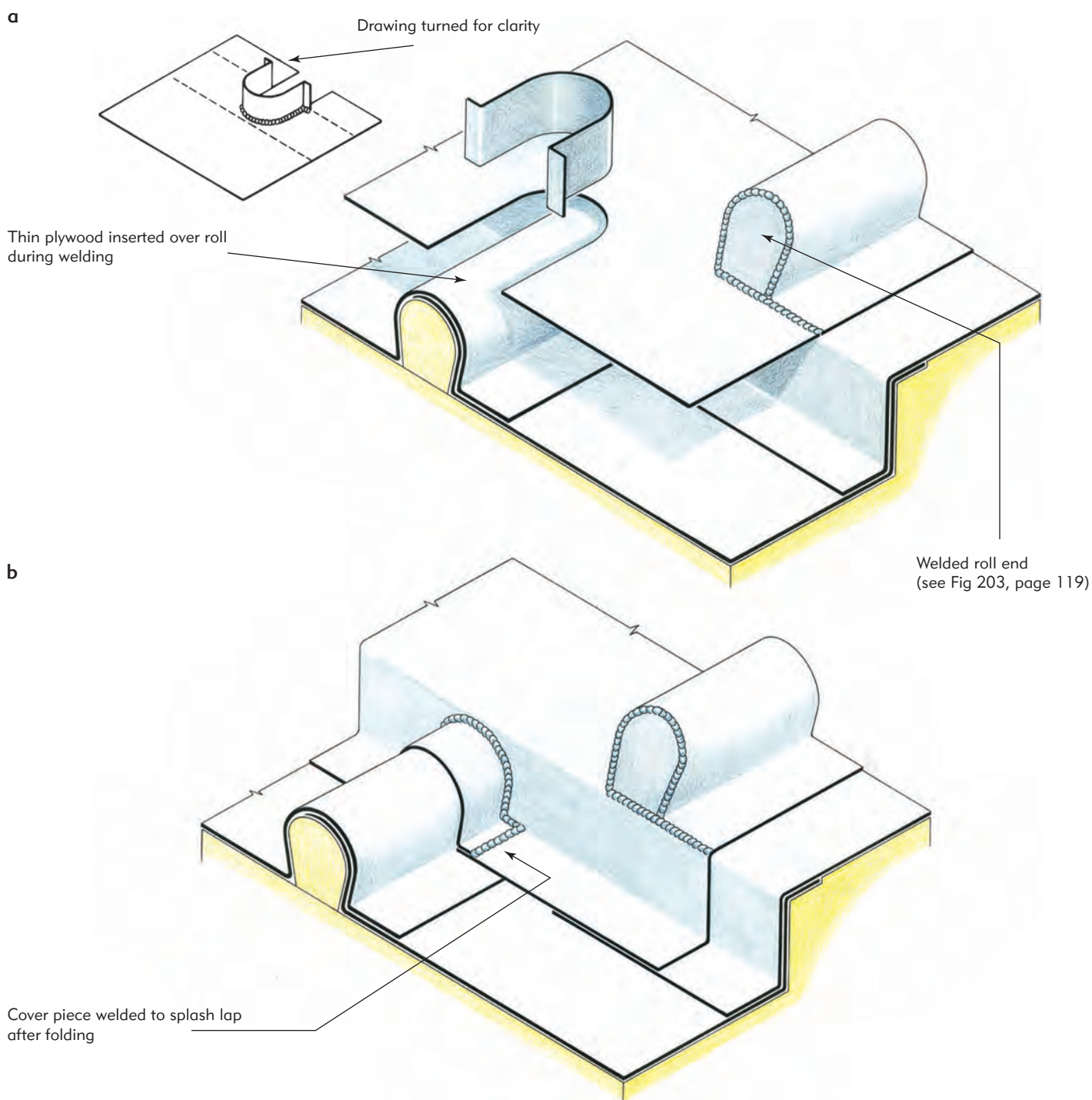


Fig 217. Staggered rolls (up to 3°) – lead-welded



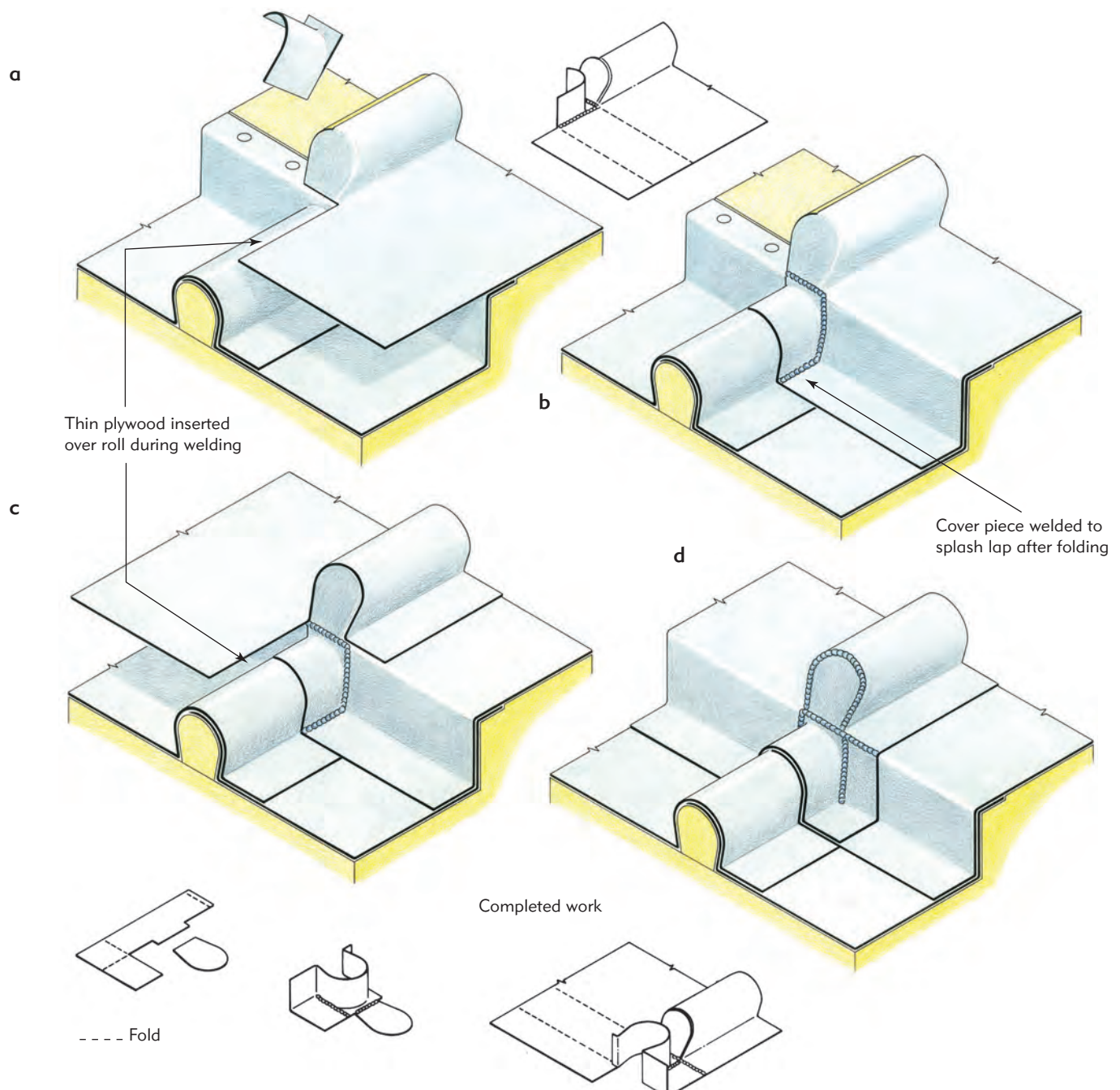
Flat roof coverings (cont.)

Roll and drip intersections (up to 3°)

When the rolls are in line, the undercloak is cut and folded, as in Fig 218a, and a cover piece is welded in while the work is in the horizontal position. The lead is then turned down and dressed into position (Fig 218b). Similarly, the overcloak is cut and folded as in Fig 218c, and the corner, together with a roll-end cap, is preformed and welded out of position. The cap is bent to the angle of the roll face and then the corner is welded to the bay while the extension is in the horizontal position. To complete the joint, the extension is folded down and the cap welded to the overcloak in-situ (Fig 218d).



Fig 218. Rolls in line (up to 3°) – lead-welded

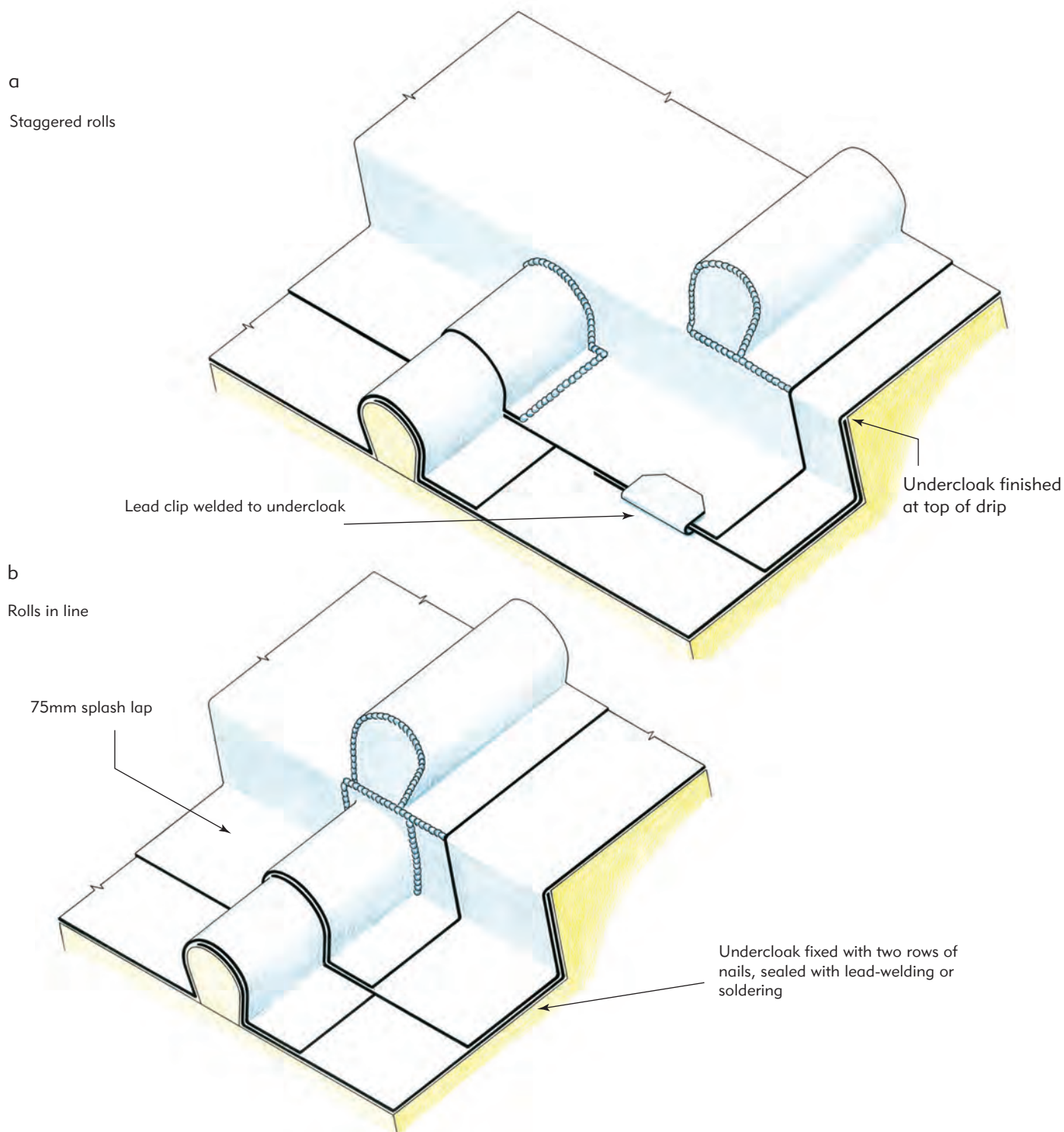


Flat roof coverings (cont.)

Roll and drip intersections (3-10°)

For roof pitches above 3°, the joints are made in a similar way to those shown for 3° and below, except that the upstand is not turned into a rebate at the top of the drip. In addition, the cover and corner pieces shown in Fig 218 are made larger to suit the splash lap, which is extended to cover two rows of nail fixings (Fig 219).

Fig 219. Roof pitches (3-10°) – lead-welded



Flat roof coverings (cont.)

Hip rolls at drip intersections

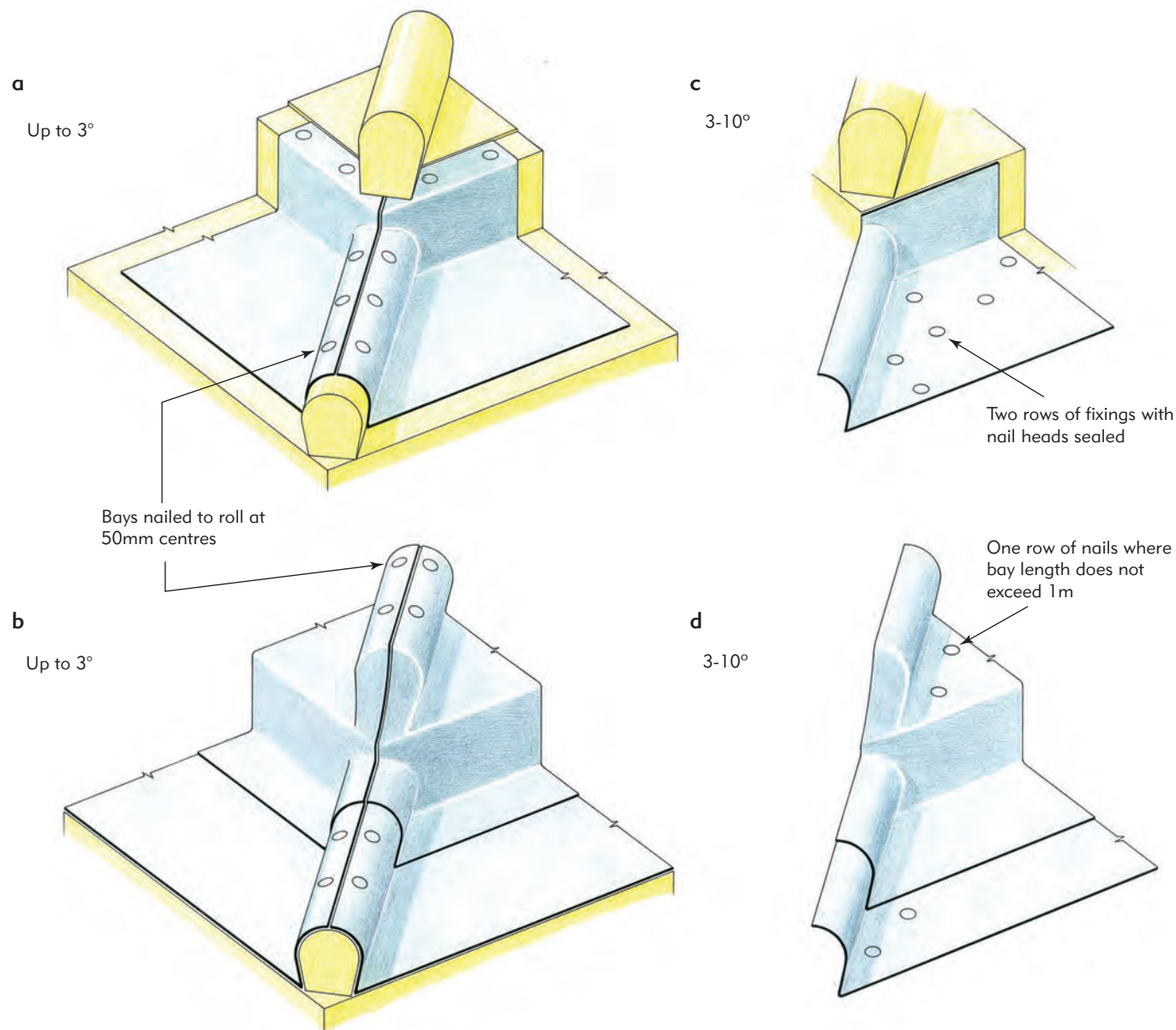
With roofs up to 3° , the roll and drip intersections at hips can be bossed or formed by welding using the traditional undercloak/overcloak method (see photo). However, this is not suitable for roofs over 3° where extra fixings are required to prevent the bays from slipping down the roof.

An alternative and practical method for all pitches up to and including 10° is to use two undercloaks and a separate capping. For pitches up to 3° , the bays are fixed as shown in Figs 220a and b. For roofs up to 10° , bays are fixed as shown in Figs 220c and d. Where the length of the bay does not exceed 1m on its longest side, one row of nails at 50mm centres will be sufficient to hold the bay permanently in position.

In many cases, a larger roll, usually referred to as a king roll, is used down the hip. Where this occurs, it is important that the drip height is increased to a minimum of 5mm more than the height of the larger roll. The corner and roll ends can be bossed or lead-welded as previously described.



Fig 220. Hips



Flat roof coverings (cont.)

Hip rolls at drip intersections

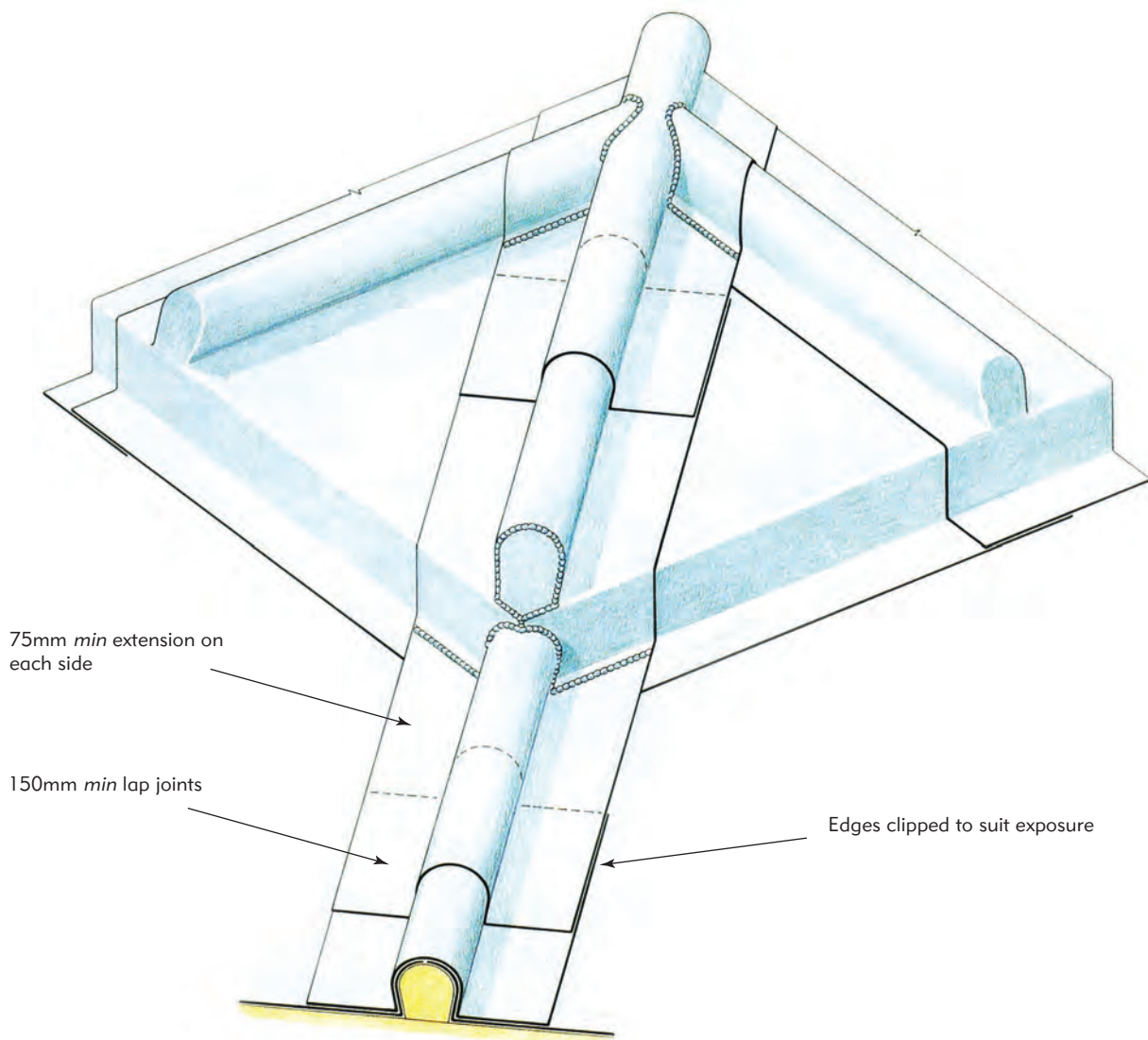
Fig 221 shows the capping piece over a roll/drip intersection. Although this junction can be formed by bossing, there is a risk of thinning the lead unduly, particularly when using codes 5 and 6 lead sheet for this work. Therefore, lead-welding is often a more practical alternative.

The position of the welds shown is one method of forming this junction, but there can be several alternative weld positions, all of which will be correct provided that the lead-welding is efficient. In addition, the weld positions for work done on the bench will differ from those for work carried out in position. Hence, there is no right or wrong way to fabricate these complex intersections – the position of the welds is the choice of the installer.

Capping pieces should not exceed 1.5m in length and each piece is secured at the head to the wood roll with copper or stainless-steel nails. Laps between pieces should be not less than 150mm and clips will be required along the free edges to suit the exposure. The minimum extension on each side of the roll is 75mm, but in exposed positions this should be increased to a minimum of 100mm for roofs up to 3°. For aesthetic reasons, the extension is often increased to between 100mm and 150mm.

At roll intersections, the capping is cut as shown in Fig 222, and pieces are fitted and then welded over the intersecting rolls. Again, this junction can be formed by bossing but, in most cases, it will be practical, economical and more efficient to use welding.

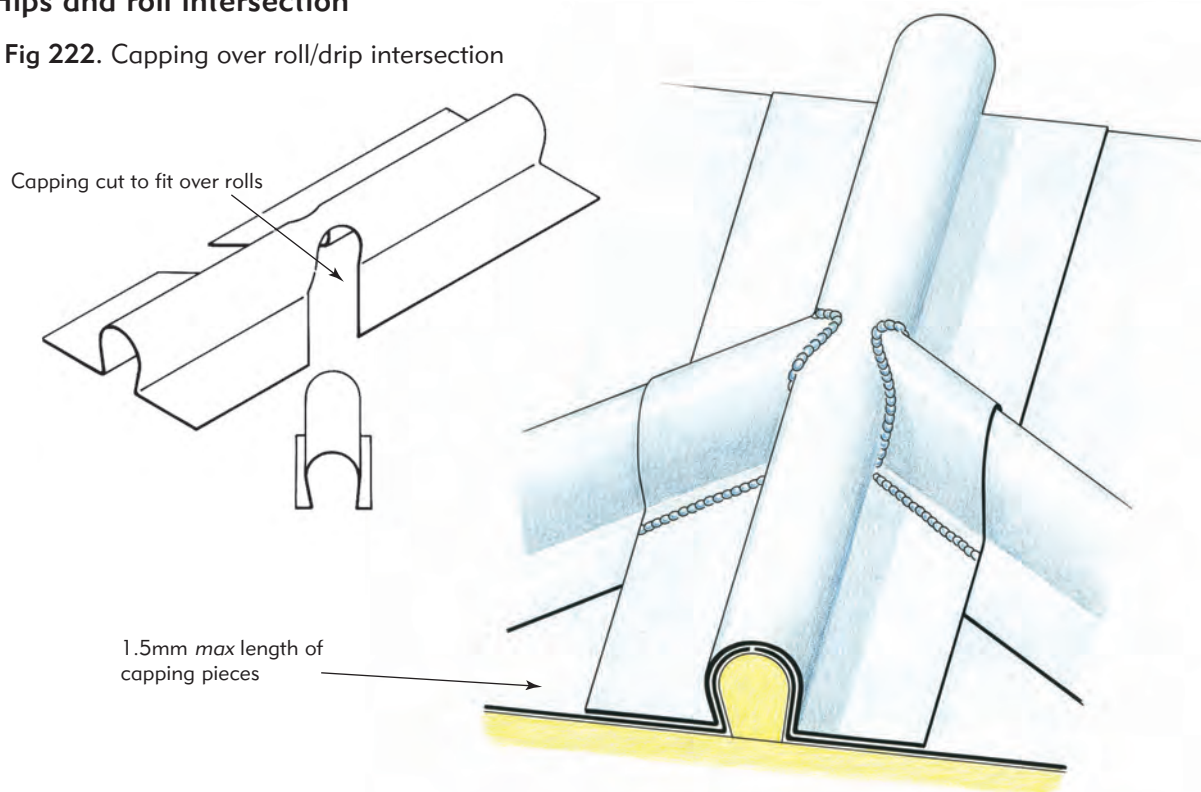
Fig 221. Capping over roll/drip intersection



Flat roof coverings (cont.)

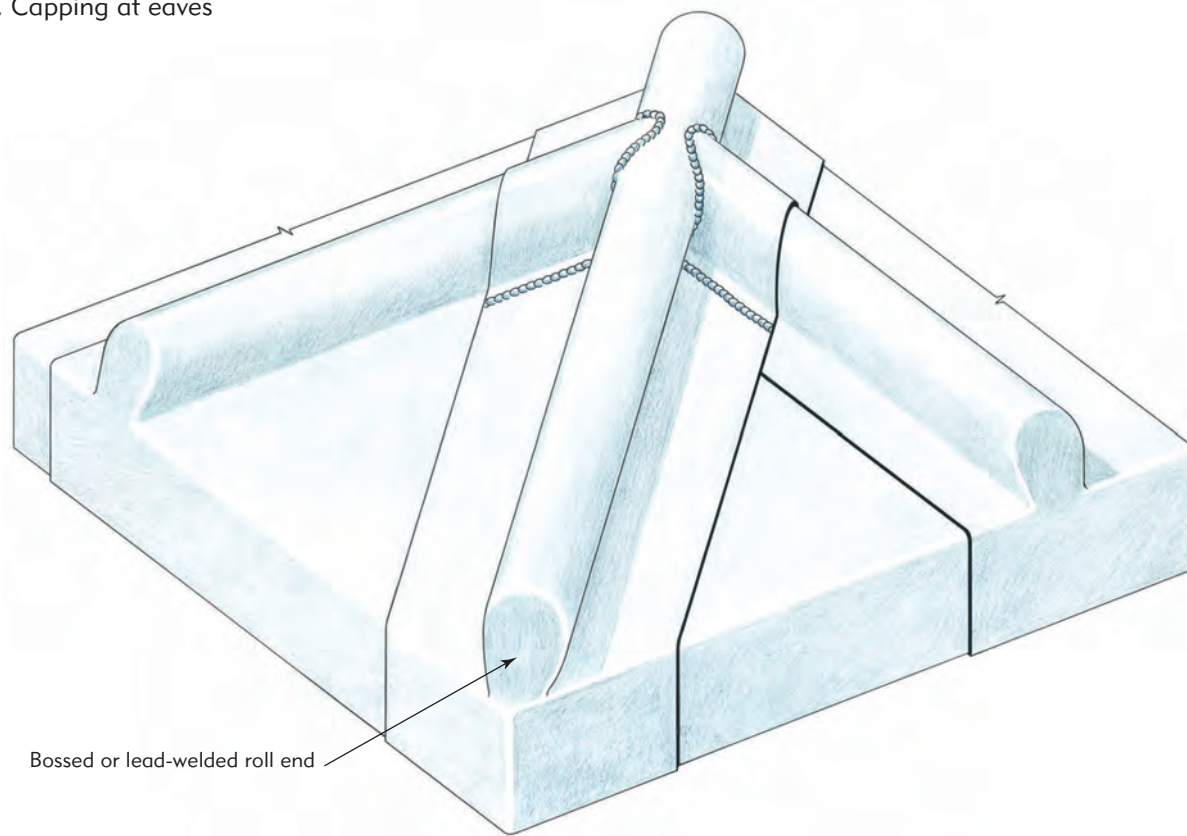
Hips and roll intersection

Fig 222. Capping over roll/drip intersection



At the eaves shown in Fig 223, the end of the capping is bossed or welded as previously described.

Fig 223. Capping at eaves



Flat roof coverings (cont.)

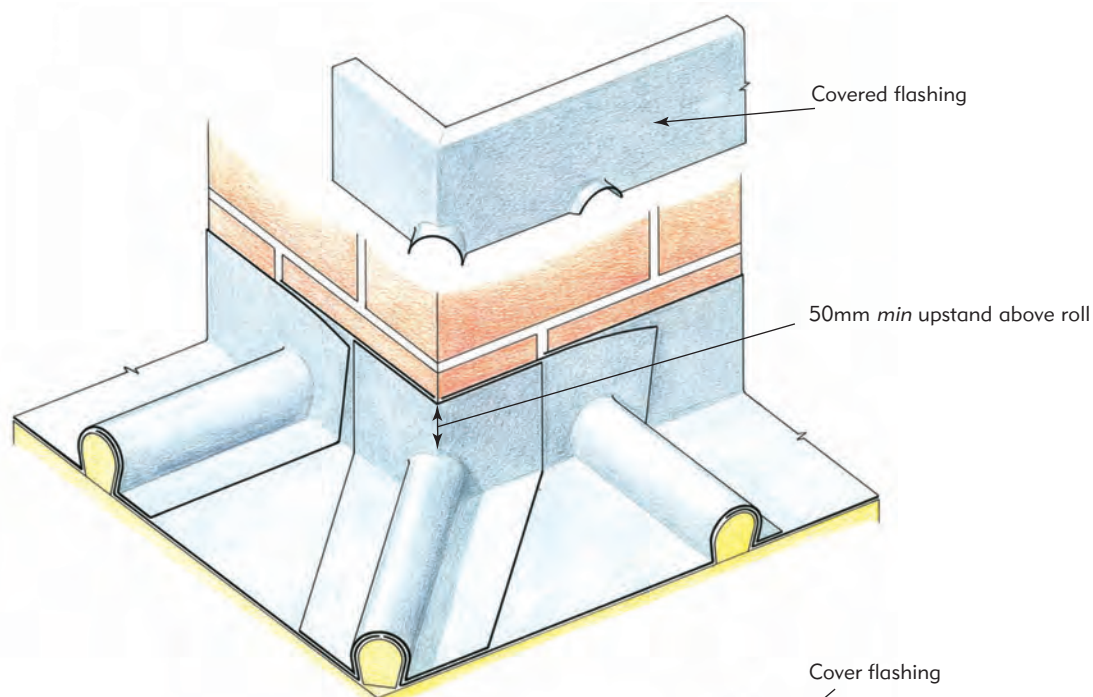
Hips at abutments

At an abutment, the capping is turned up against the wall and weathered with a cover flashing (Fig 224a). For pitches up to 3° , the intersecting roll will keep the top capping piece in position but fixings will be required above 3° up to and including 10° (Fig 224b).

Fig 224. Capping at abutment

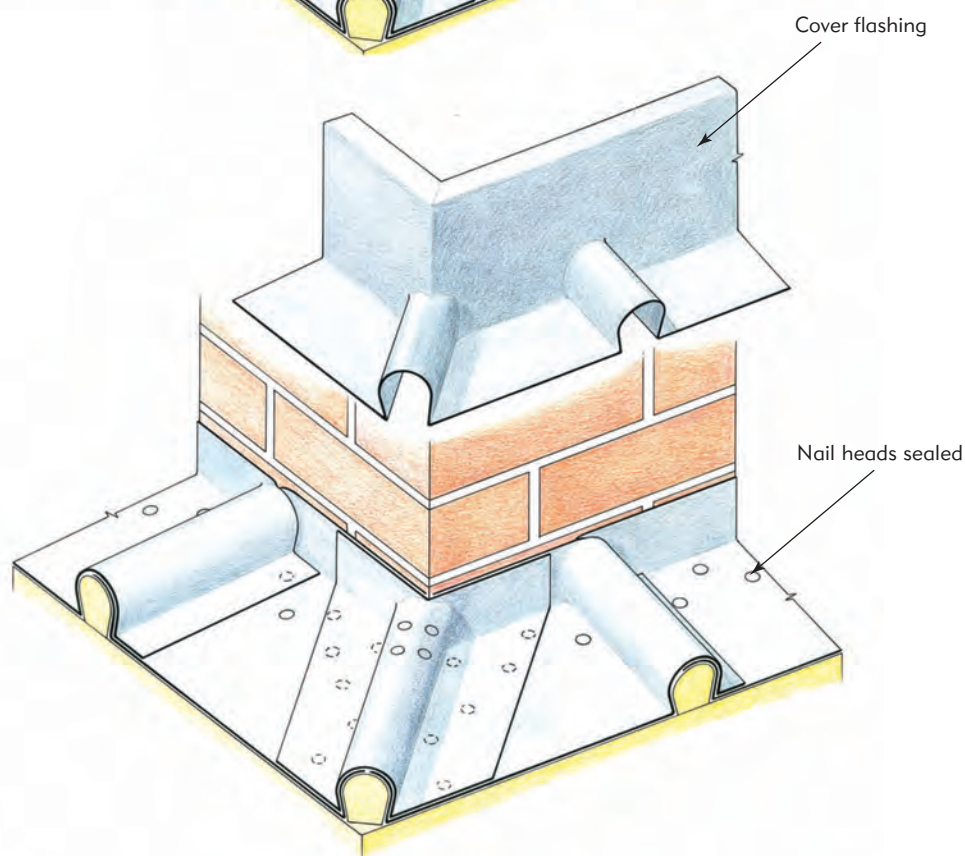
a

Up to 3°



b

3- 10°



Flat roof coverings (cont.)

Ridges

Where two areas of flat roofing meet at a ridge, the detailing is similar to a hip. Two undercloaks are used with a separate capping. Additional fixings are required for pitches over 3° up to and including 10° .

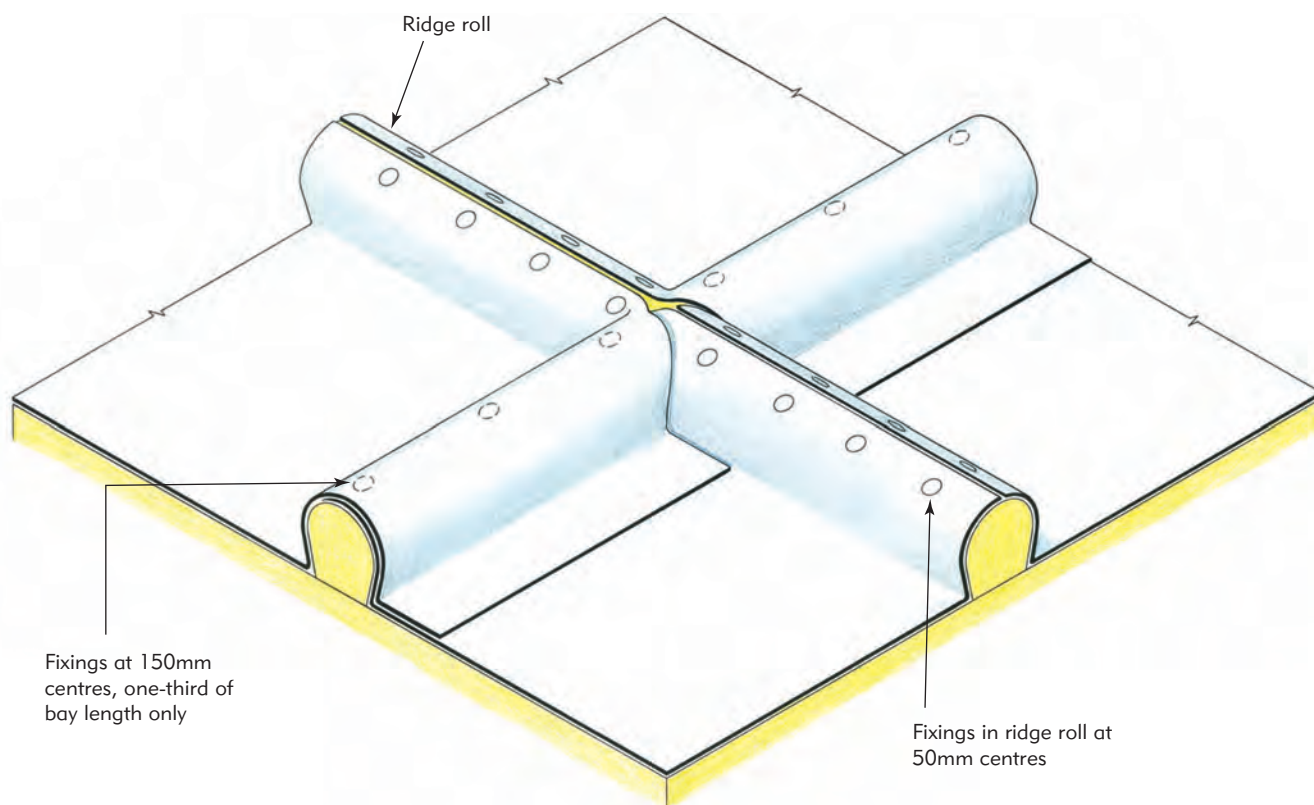
Figure 225 shows the undercloaks in position for a roof pitch up to 3° using standard rolls for both roof and ridge. If a larger roll is used along the ridge, the upstand at the top of the bays is increased so that the undercloaks meet at the top of the large roll. The head of each bay is nailed to the ridge roll at 50mm centres and, at 150mm centres, fixings are required in the top third of the undercloak side of each bay. For pitches over 3° , the fixings should be positioned as shown in Fig 226 and, because water will infiltrate the fixing area, the nail heads should be sealed over with solder or welded dots.

Capping pieces should not exceed 1.5m in length, with 150mm-minimum lap joints (Fig 227). However, for aesthetic reasons, normally the laps are positioned in the centre of every second bay. As with hip cappings, the extension at the sides of the capping should be a minimum of 75mm, although 100mm is recommended for roofs up to 3° in exposed positions. Clips are required along the free edges to suit the exposure.

The alternative traditional method of bossing these four-way wood-cored roll joint intersections is labour intensive and difficult to achieve without thinning the corners unduly. Hence, bossing is not recommended, particularly when the thinner codes of lead sheet are specified.



Fig 225. Intersection of rolls at ridge (up to 3°)



Flat roof coverings (cont.)

Ridges

Fig 226. Intersection of rolls at ridge (3-10°)

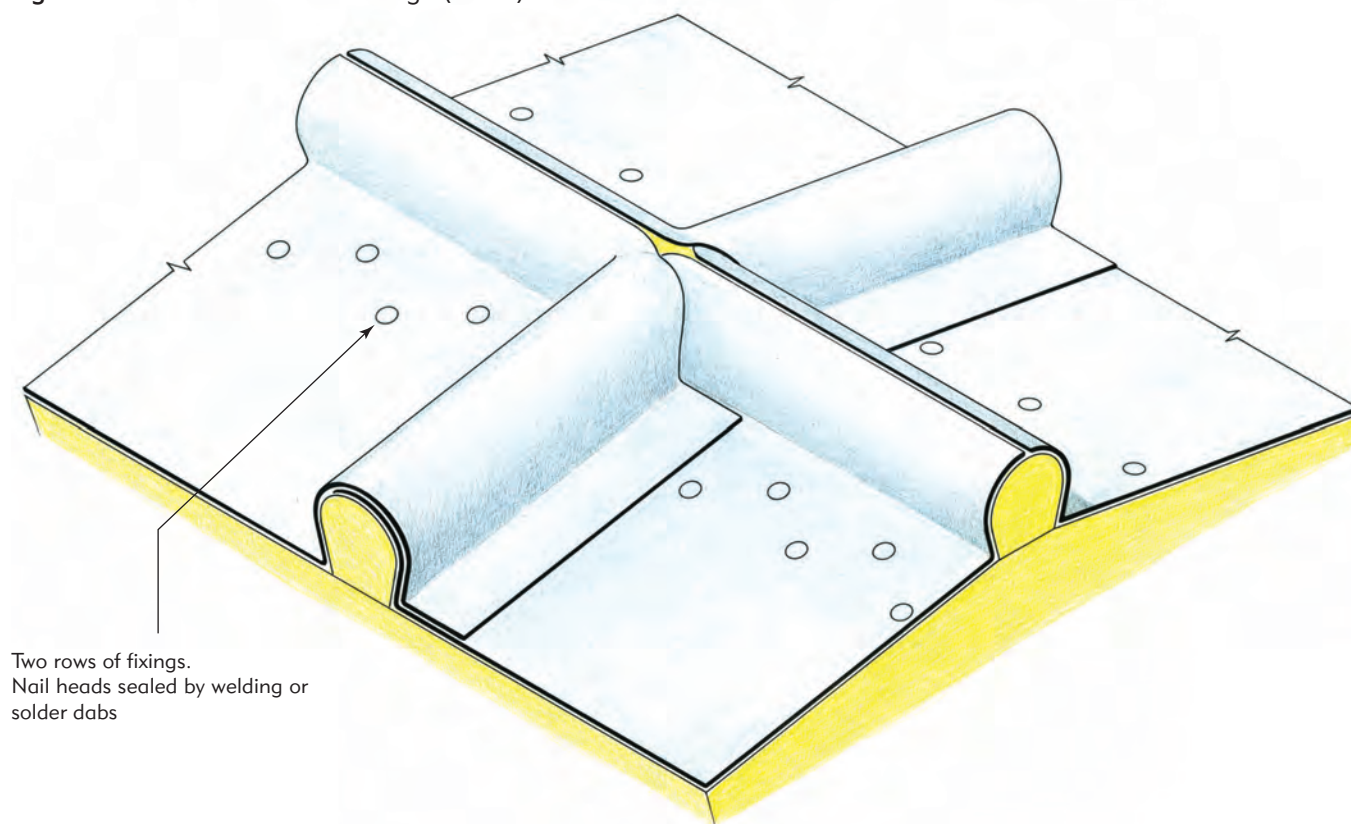
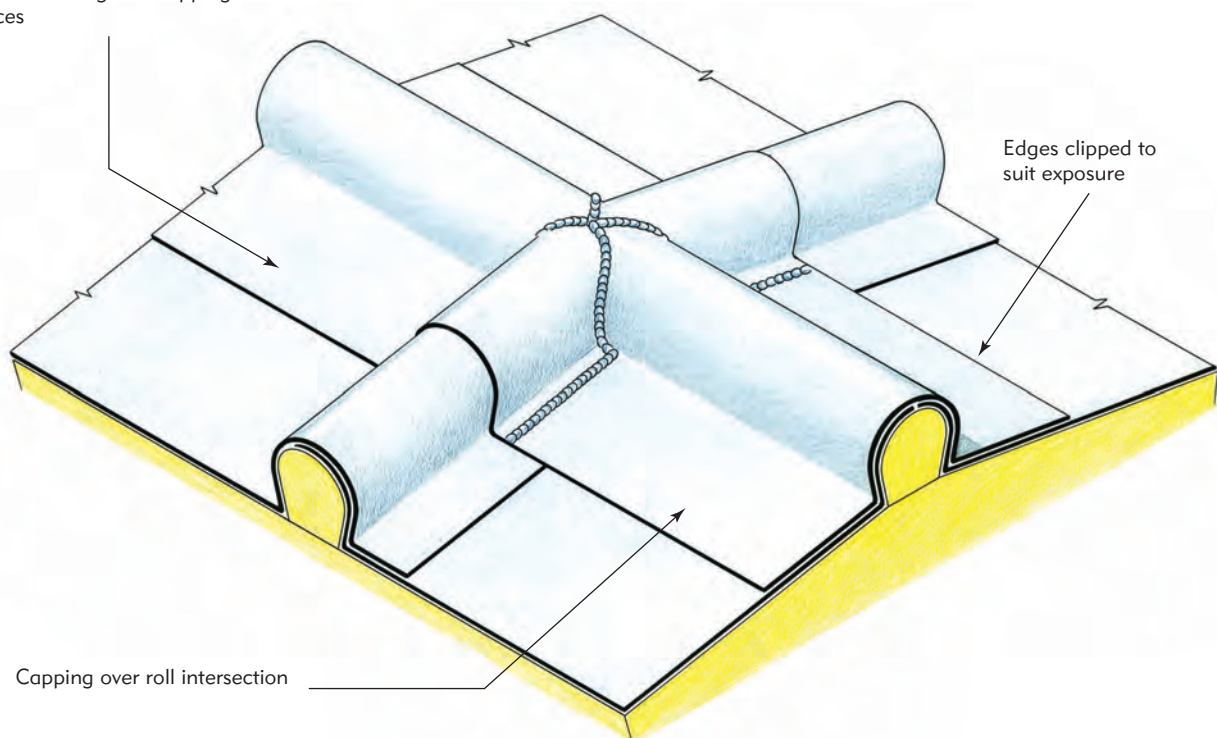


Fig 227. Intersection of rolls at ridge – capping piece

1.5m max length of capping pieces



Flat roof coverings (cont.)

Valleys

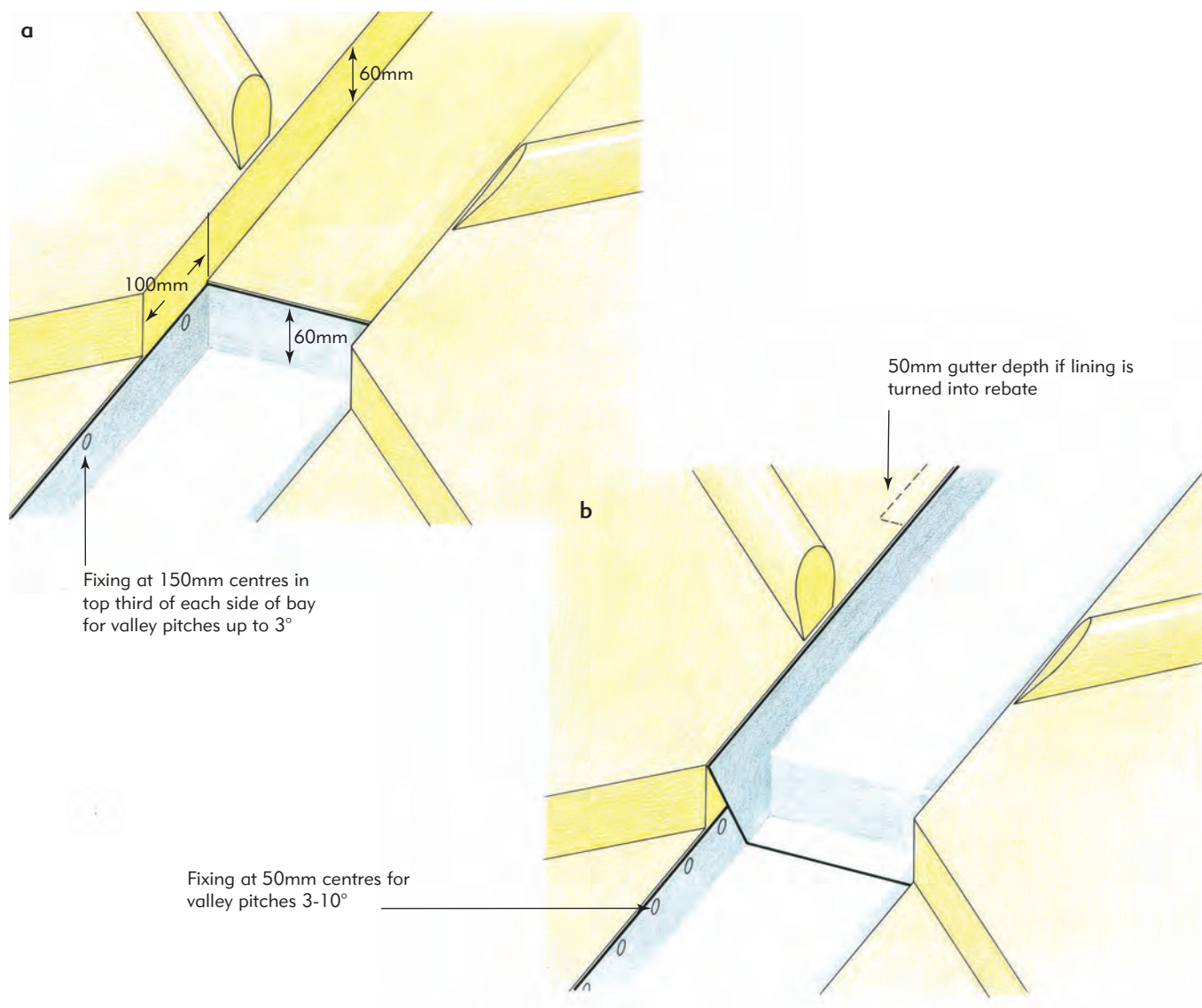
Where two areas of roofing meet at a valley, it is necessary to construct a shallow box gutter. The depth of the gutter will depend on the size of the roof and the anticipated rainwater discharge into the gutter. For most situations, a depth of 50mm and a gutter width of 150mm will be adequate. If the linings are fixed at the sides, as shown, the gutter depth should be increased to 60mm.

The maximum spacing of drips in the gutter will depend on the thickness of lead sheet used for the linings (see Table 8, page 93). In many cases, it is desirable for the gutter drips to line up with the drips across the roof on each side of the valley. This means that the gutter lengths will be greater than the length of the longest roofing bays. In these situations, the lead used for the gutter linings can be thicker than that used for the roofing bays.

Where roof drips intersect with a drip in the valley, it is necessary to locate the gutter drip about 100mm back from the roof drip to achieve a weather-tight joint at the corner (Fig 228a, b, c and d). The drips are formed by bossing or lead-welding, as already described.

Although the top edge of the gutter upstands can be turned into a rebate for fixing, it will be easier to omit the rebate and fix the top third of both sides of each gutter section as shown. The nail fixings should be positioned about 10mm from the top edge at 150mm centres. If the valley pitch exceeds 3° , the fixings should be spaced at 50mm centres. The roofing bays turn down over the gutter upstands to finish 3-5mm above the gutter sole.

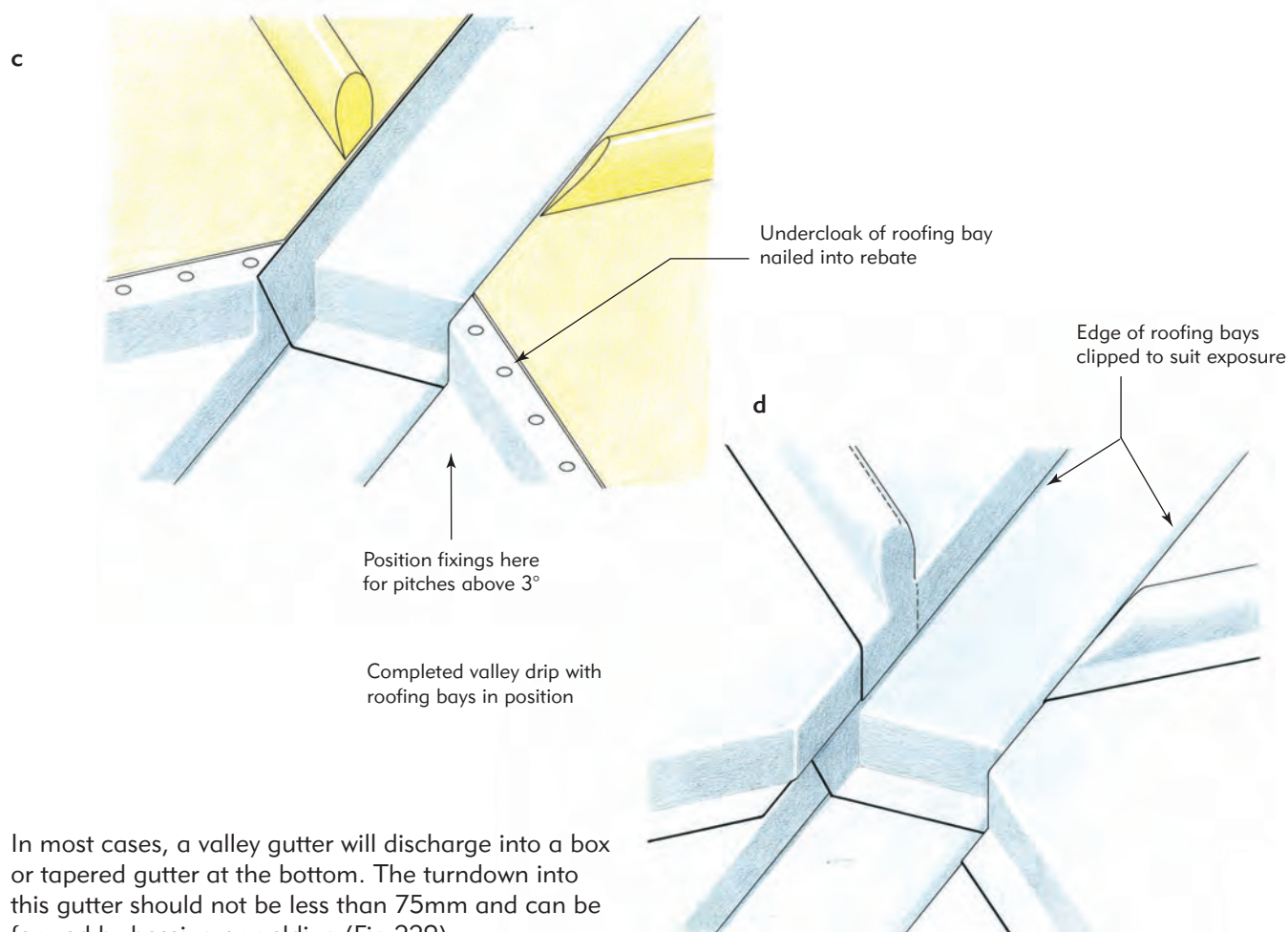
Fig 228. Valley with drip



Flat roof coverings (cont.)

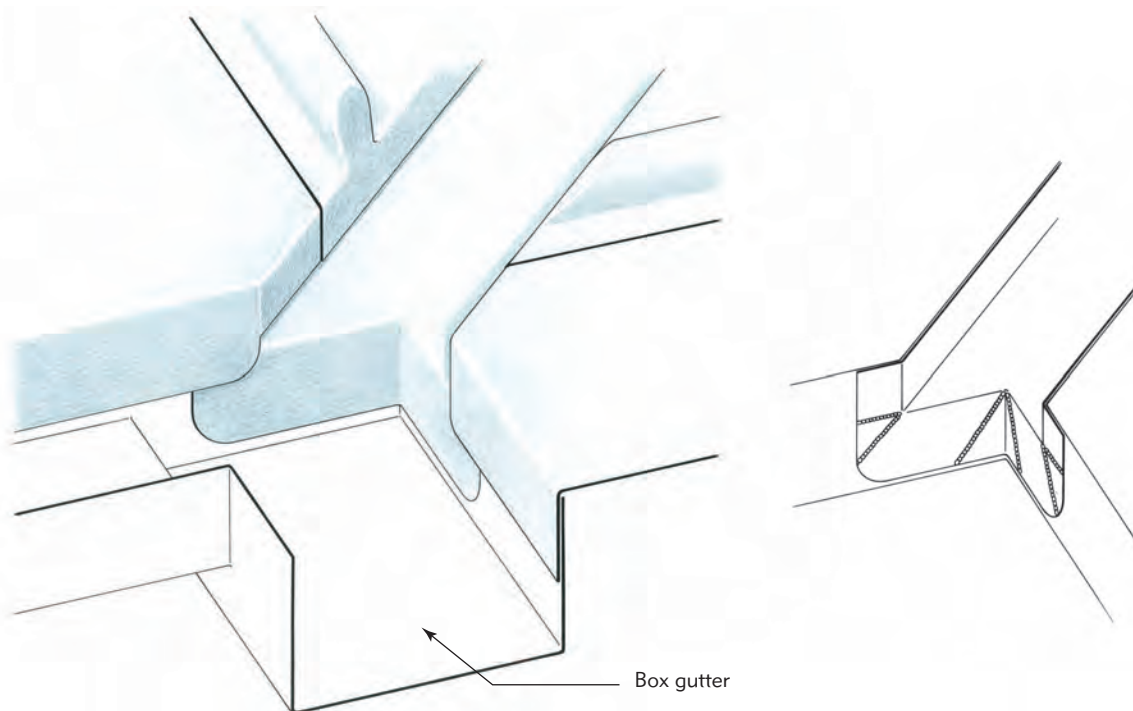
Valleys

Fig 228 (cont.) Valley with drip



In most cases, a valley gutter will discharge into a box or tapered gutter at the bottom. The turndown into this gutter should not be less than 75mm and can be formed by bossing or welding (Fig 229).

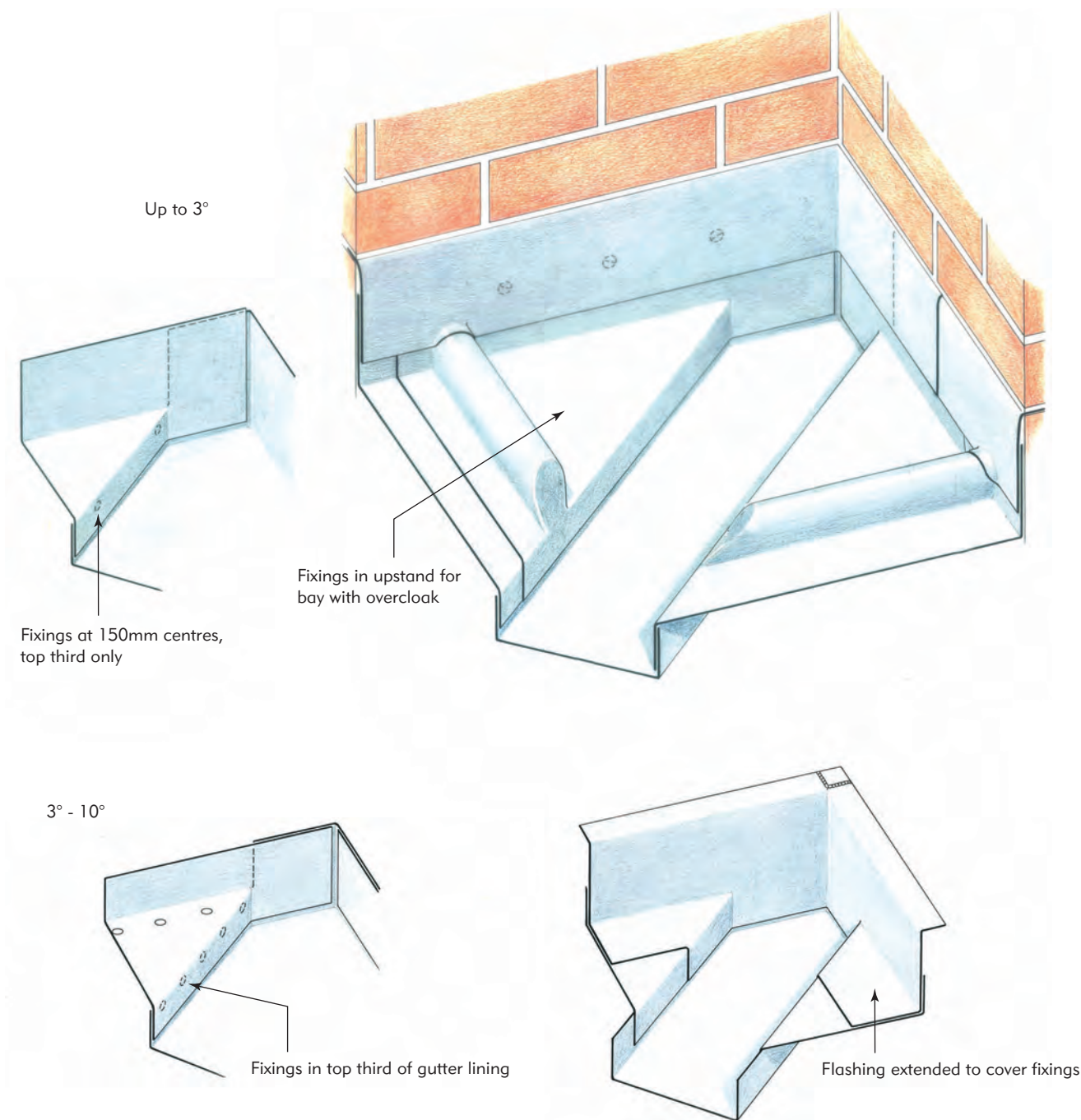
Fig 229. Valley at eaves into box gutter



Flat roof coverings (cont.)

Valleys

Fig 230. Valley at abutment



At an abutment, the gutter is turned up the wall and the top edge weathered with a cover flashing (Fig 230). The method of fixing the top length of gutter lining is as already described for the drips.

Where the small bay shown has an overcloak, it can be retained in position by screwing the upstand to the wall. The adjacent bay is secured by the nail fixings in the undercloak.

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 length (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 length (mm)
4	500	1500
5	600	2000
6	675	2250
7	675	2250
8	750	2250



Pitched roof coverings

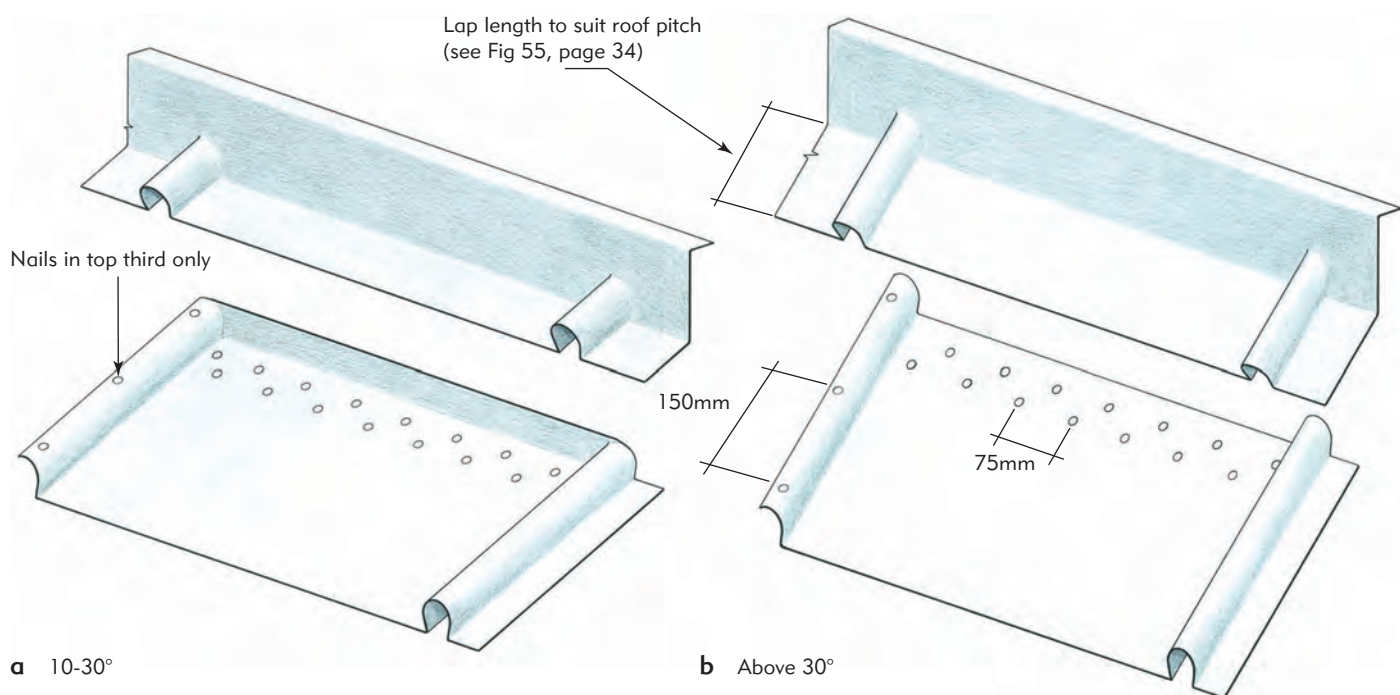
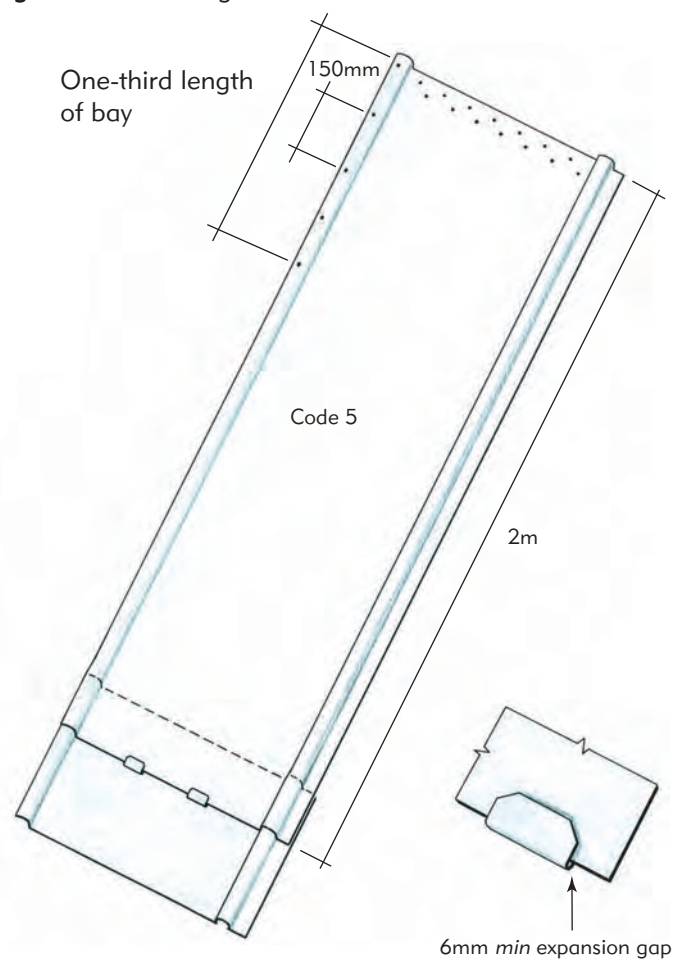
Methods of fixing

With pitched roofs up to 80° , each bay of lead sheet is held in position by two rows of copper or stainless-steel nails (Fig 231). When wood-cored rolls are used for the joints with the fall, additional nails are used in the top third of the undercloak only. Three rows of nails are recommended when using codes 7 and 8 lead sheet on roofs over 60° . These head fixings hold the individual bays firmly in position while allowing the lead to move freely towards the bottom when subjected to an increase in temperature. It is important, therefore, that retaining clips along the bottom edge are turned to permit this movement. If the clips are turned tightly around the lower edge, the lead will buckle above the clip, or cause the clip to open and become ineffective.

Figs 232a and b shows two methods of fixing the top of a bay abutting a wall. For pitches up to about 30° , it is usual to turn the top of the bay 50mm up the wall and seal the nail heads before covering with a flashing. For steeper pitches, it is not necessary to turn the lead up the wall or seal the nails, provided that the lap between the cover flashing and the top of the bay conforms to the lap requirements of Fig 55 (page 34).

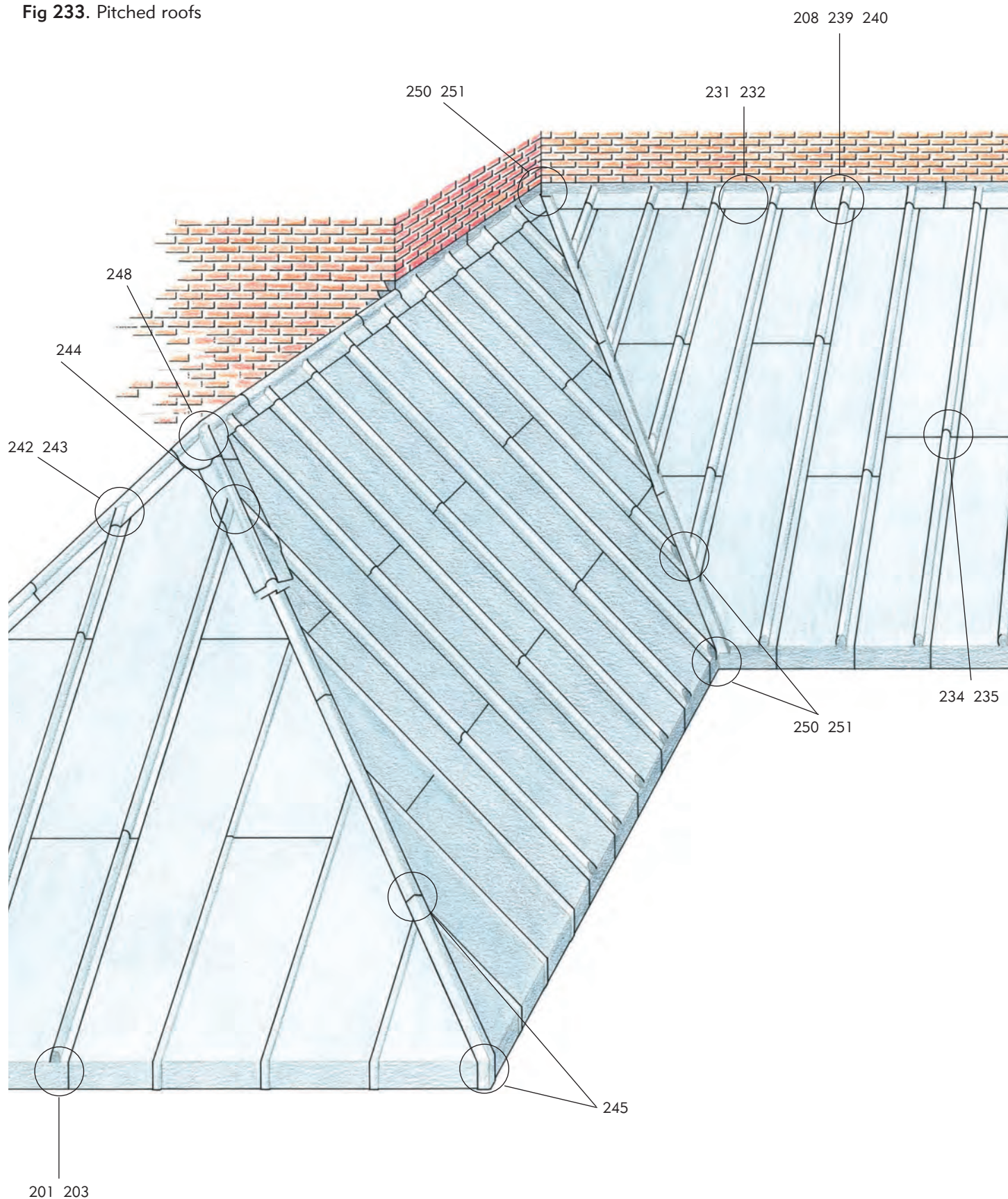
Fig 232. Fixings at abutment

Fig 231. Head fixings



Pitched roof coverings (cont.)

Fig 233. Pitched roofs



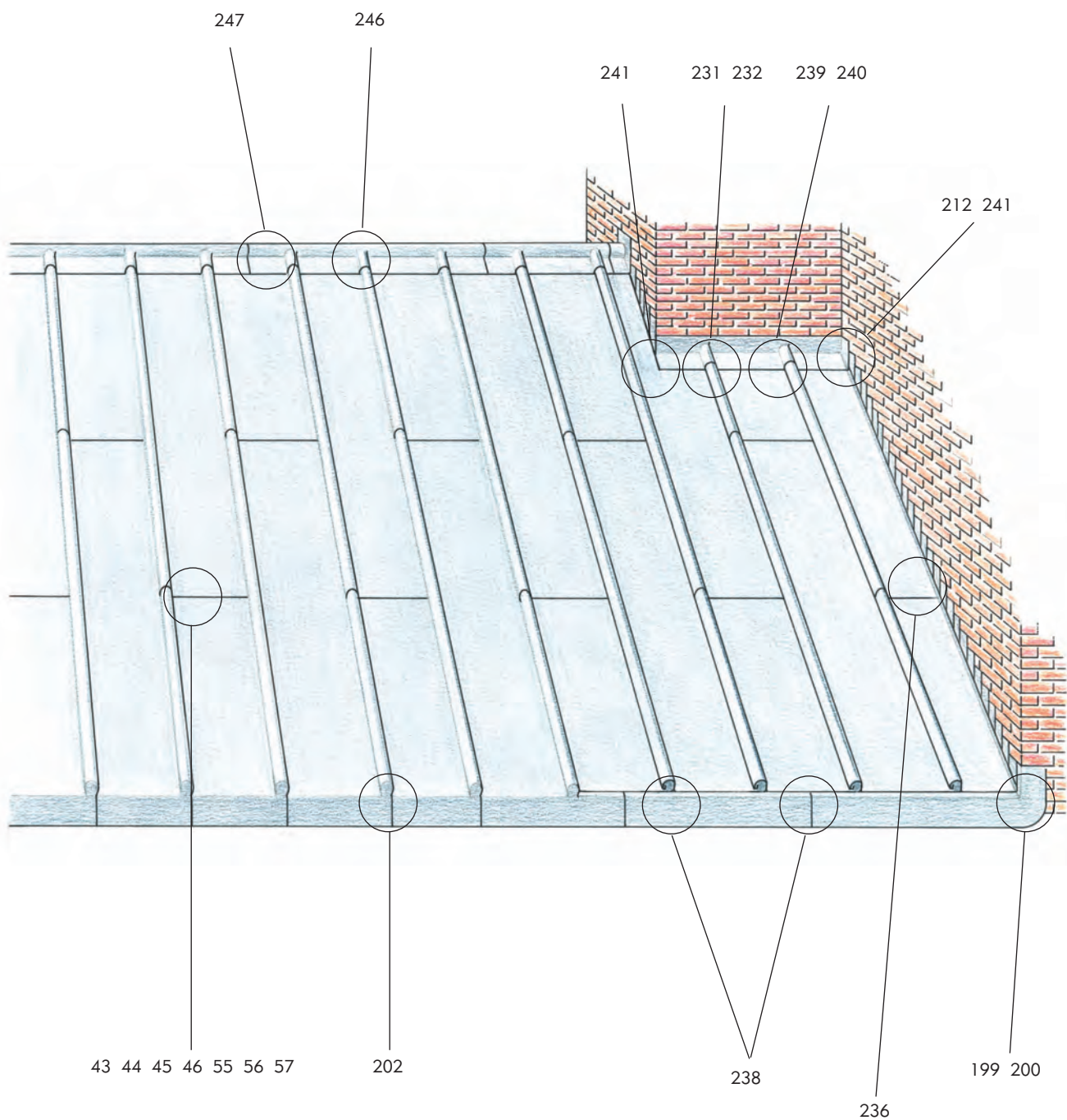


Fig 233 is an illustration showing the most common details associated with lead-covered pitched roofs. The annotations indicate the figure numbers in which the relevant detail is described and illustrated.

Pitched roof coverings (cont.)

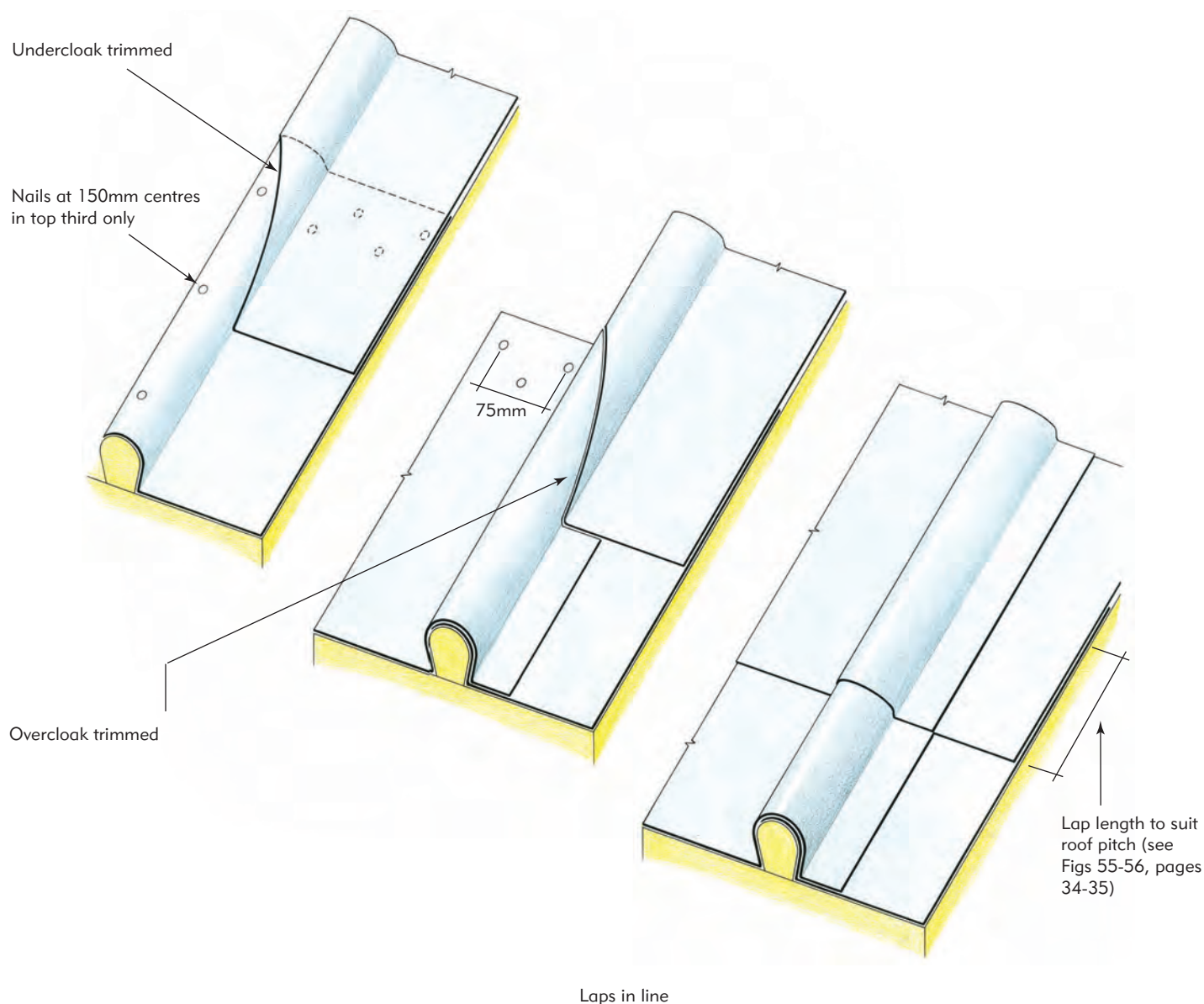
Leadwork details

Many of the details that arise with pitched roofing are similar to those for flat roofs – for example, bossing or lead-welding a roll end at the eaves. In other positions (such as bossing an internal corner), the work will be easier because the amount of bossing decreases as the roof pitch increases. The main difference with roofs over 10° is that laps can be used for the joints across the fall, whereas drips must be used on roofs of 10° and below.

Laps

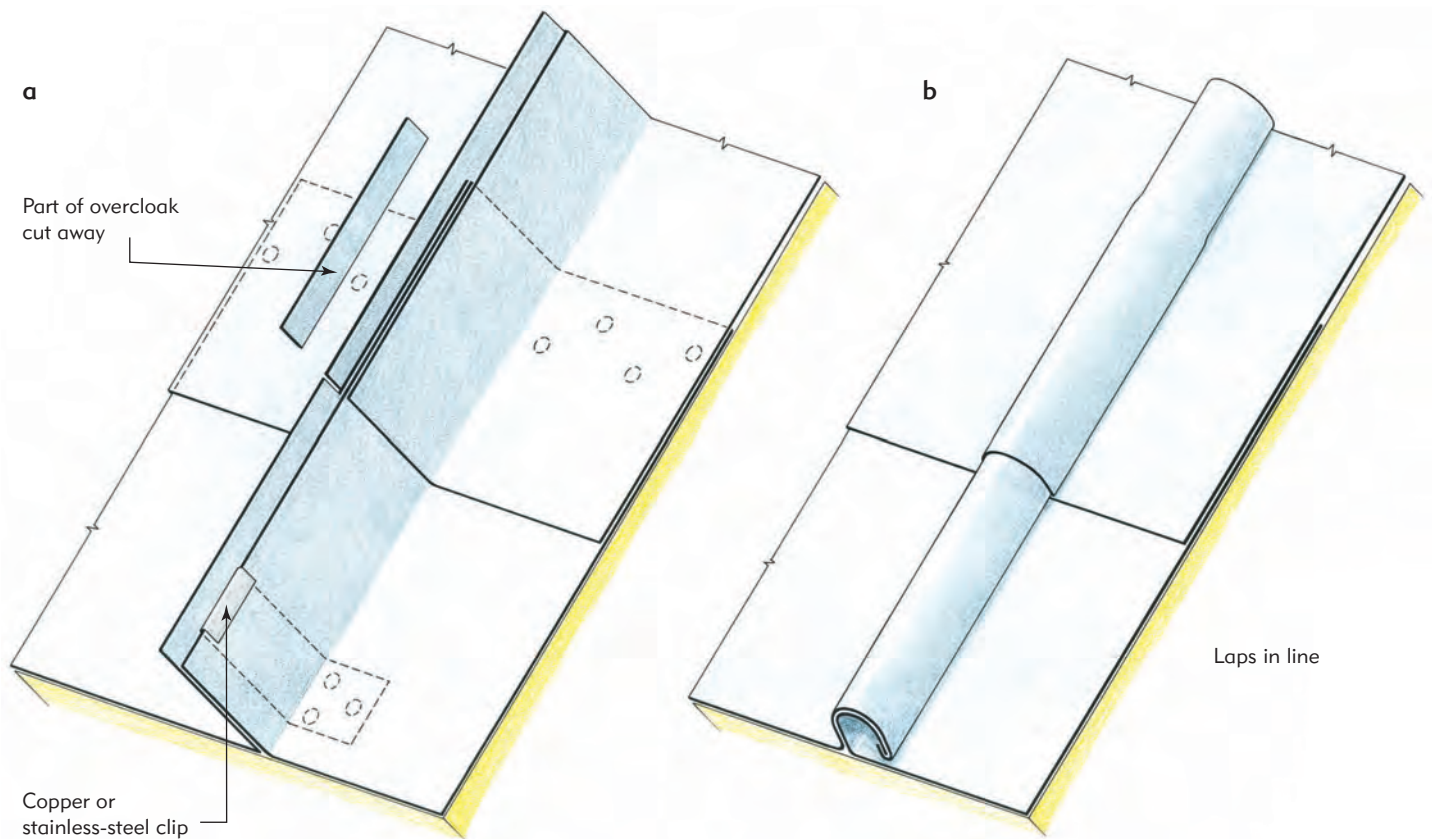
The amount of lap depends on the pitch of the roof (Fig 55, page 34). For severe exposures, particularly on pitches above 45° , it is recommended that the minimum vertical height of 75mm is increased to 100mm. Laps are usually staggered from bay to bay to avoid a build-up of thicknesses where they intersect with the rolls. However, for aesthetic reasons they are sometimes fixed in line – Fig 234 shows a method of reducing thickness at a wood-cored roll intersection. This method is particularly useful when using the thicker codes of lead sheet.

Fig 234. Roll/lap intersections – laps in line



Pitched roof coverings (cont.)

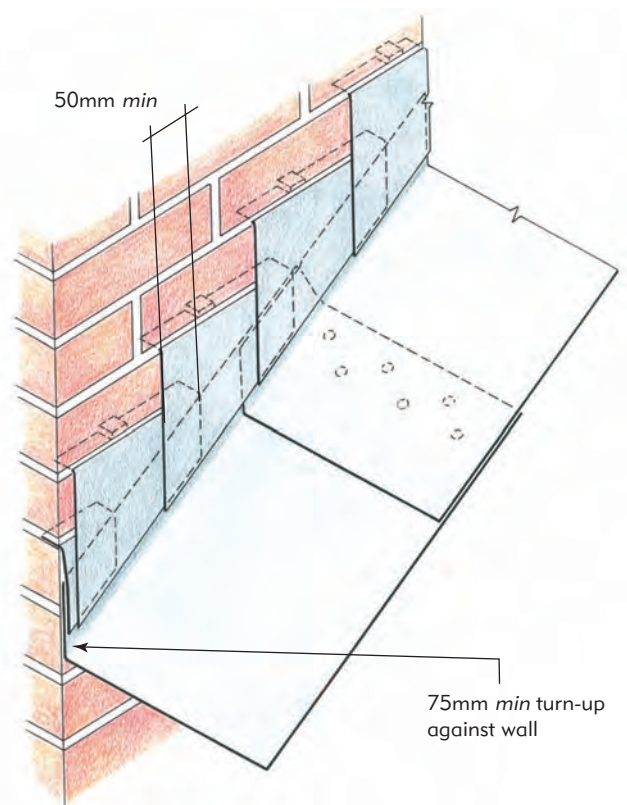
Fig 235. Hollow roll – laps in line



If laps are in line when using hollow rolls, it is not practical to reduce the number of thicknesses, except where the overcloak turns over the undercloak (Fig 235a). However, the build-up of thicknesses is more readily acceptable within the hollow roll and, with care, the bulge at the intersection can be minimised (Fig 235b).

At an abutment, the lap extends up the wall by a minimum of 75mm and is weathered with a flashing (Fig 236).

Fig 236. Lap at abutment



Pitched roof coverings (cont.)

Finish at eaves

At the eaves, the lead covering may be turned down over the top of a fascia and into an eaves gutter, or turned down to cover the upstand of a lead gutter lining. The methods of bossing or welding the ends of wood-cored rolls are as already described for flat roof coverings. Where welts are used, they can be simply turned down with the roof covering. Similarly, on steep roofs a hollow roll can be bent around the angle (Fig 237).

However, for most pitches the hollow roll detail shown in Fig 238 is recommended. The roofing bays are lapped over an eaves flashing with the roll ends left open, thereby permitting a free flow of air to the length of the rolls. Any debris, such as leaves, that collects within the hollow roll will be readily washed out during heavy rain. Each piece of eaves flashing should not exceed 1.5m in length with 100-150mm end-to-end lap joints, depending on the severity of exposure.

Fig 237. Hollow roll at eaves – steep pitches

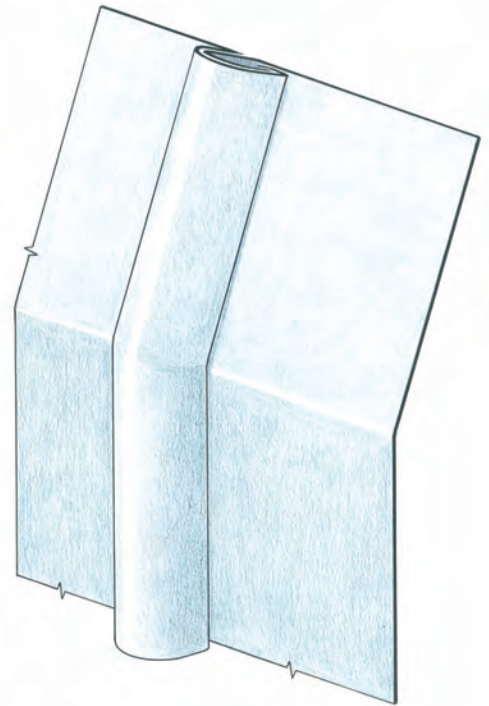
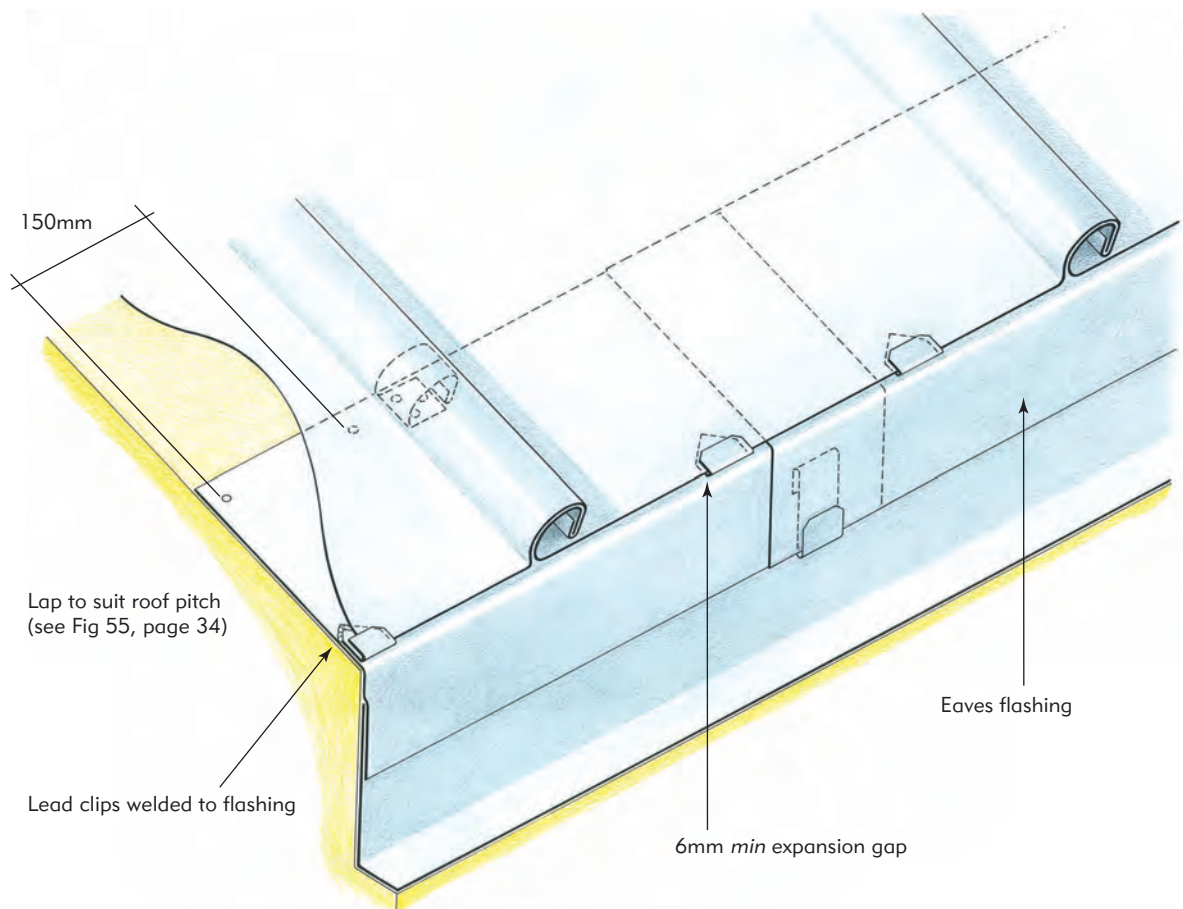


Fig 238. Hollow rolls with eaves flashing



Footnote:

Other methods of roll termination can be used. This is down to installer/specifier preference.

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)

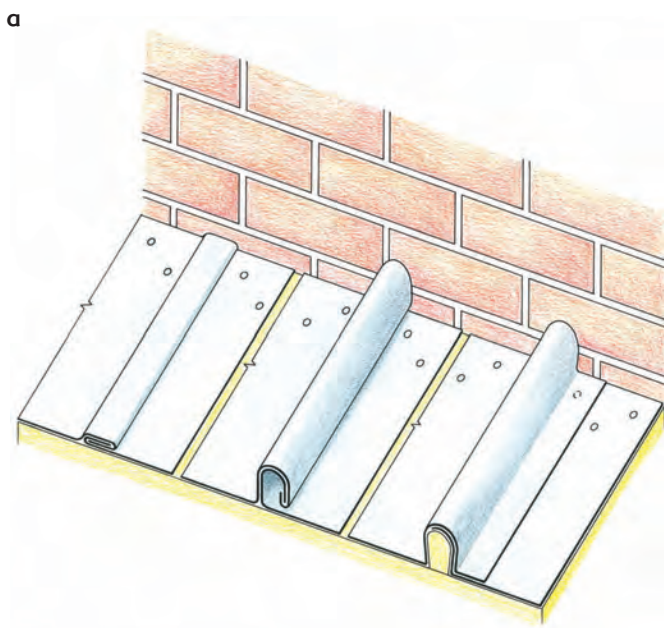
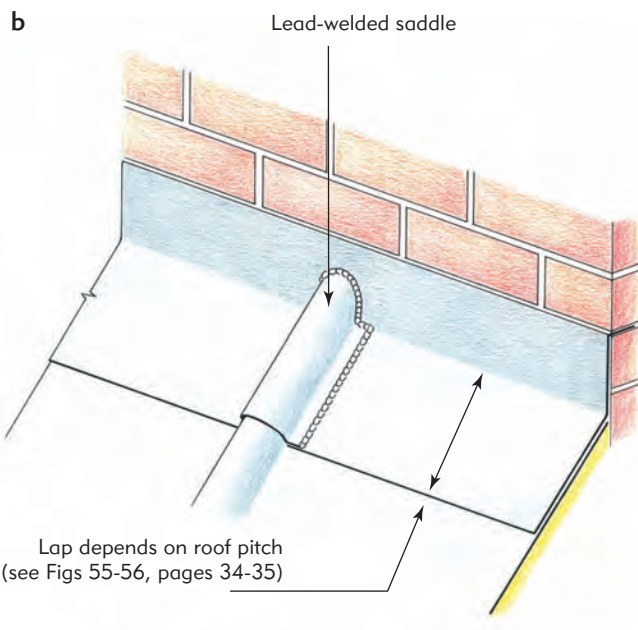
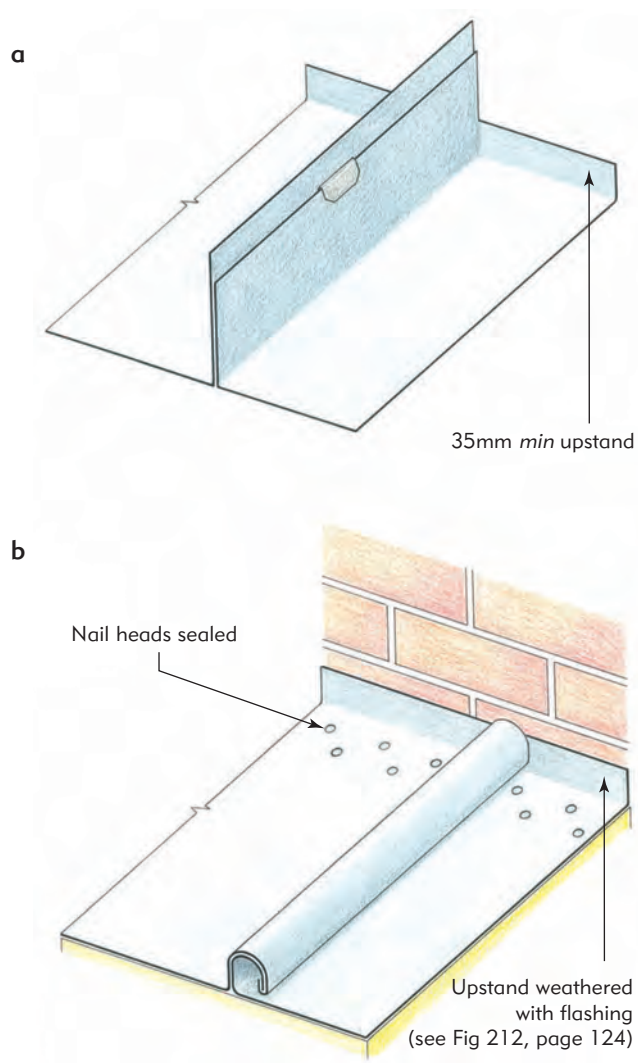


Fig 239. Hollow roll at abutment (10-30°)



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.

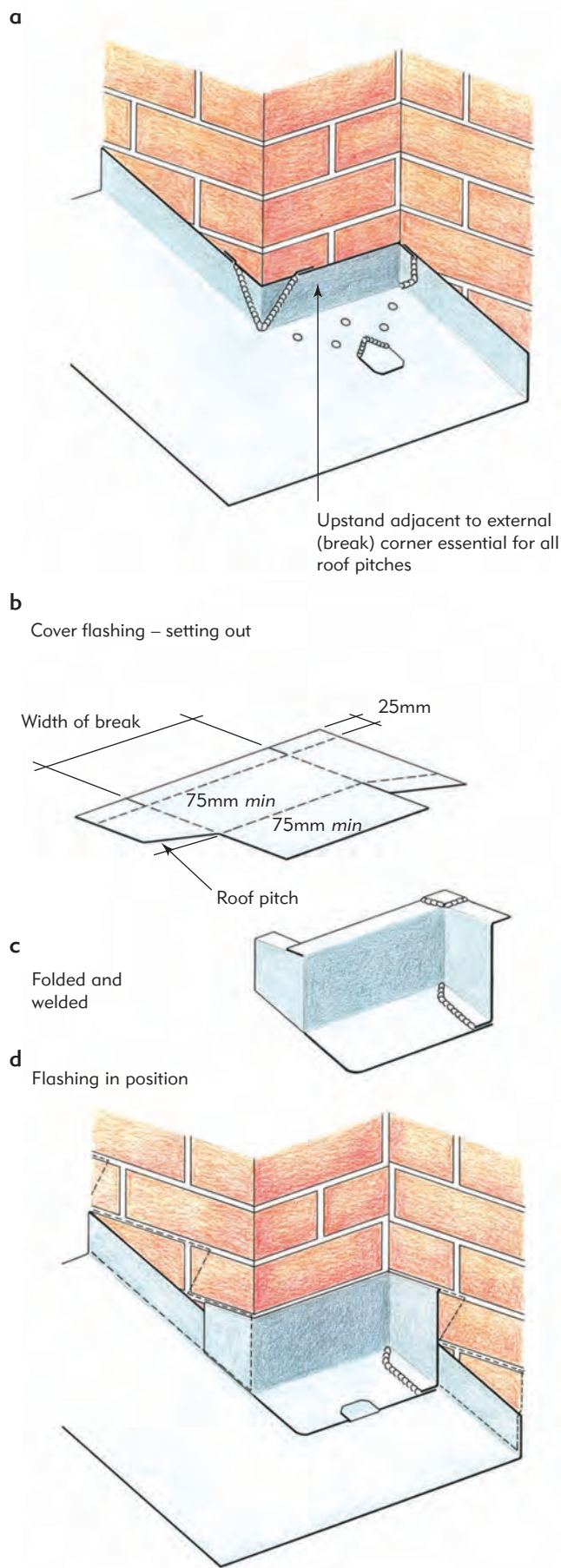
Both corners can also be formed using similar lead-welding methods (Figs 193 and 195), with the gusset required for the break corner decreasing in size as the roof pitch increases.

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

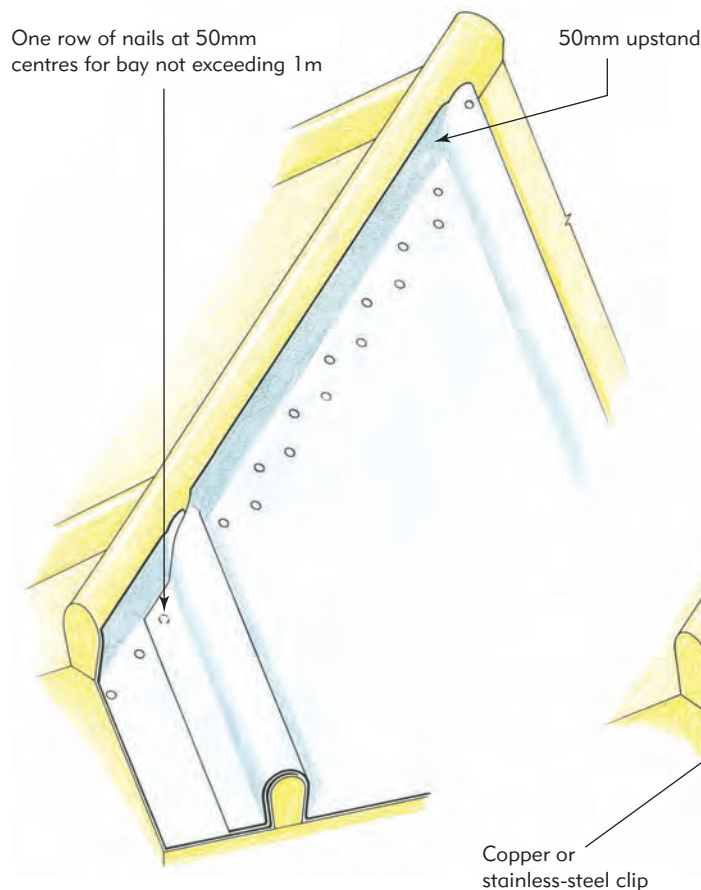
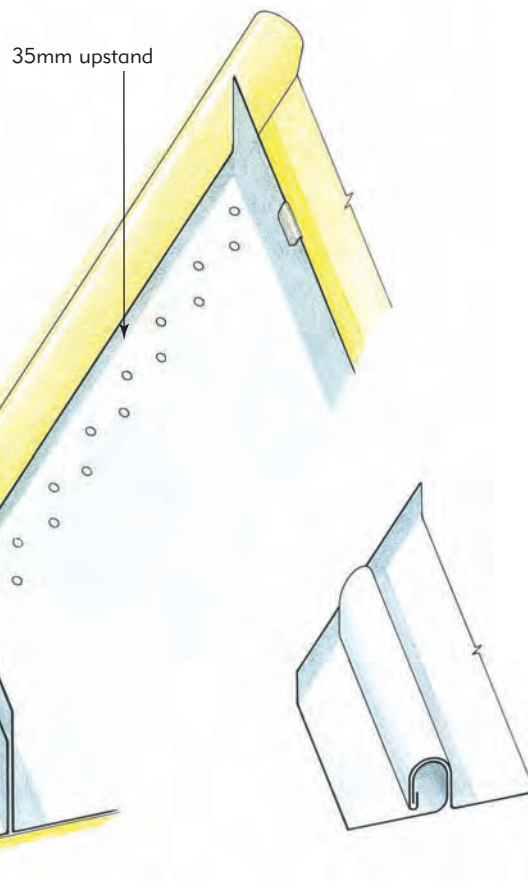


Fig 243. Hollow roll abutting hip

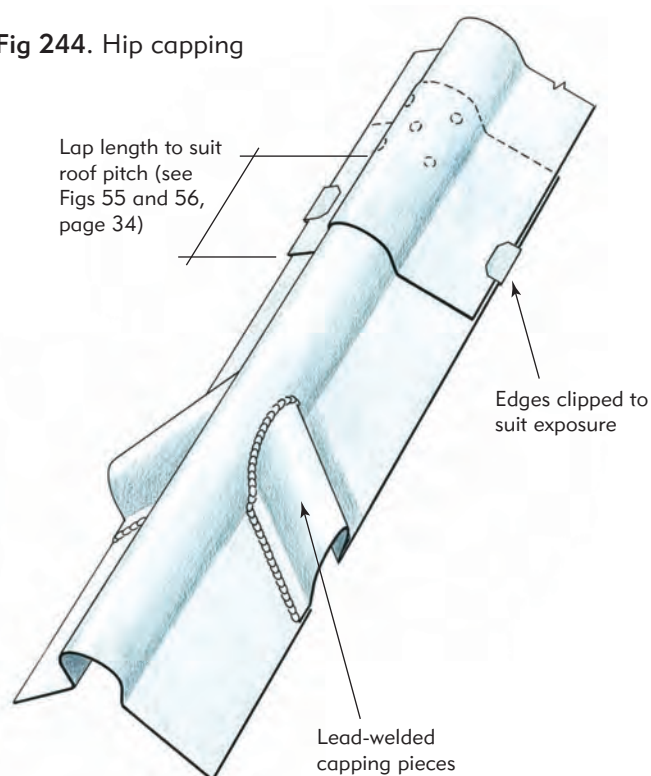


Where roofing bays abut a hip roll, detailing is similar to an abutment at a wall. When wood-cored rolls are used, the top of the bay is turned up about 50mm (Fig 242), and for hollow rolls about 35mm (Fig 243). The bays are fixed with two rows of nails at 75mm centres, or one row at 50mm centres if 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.)

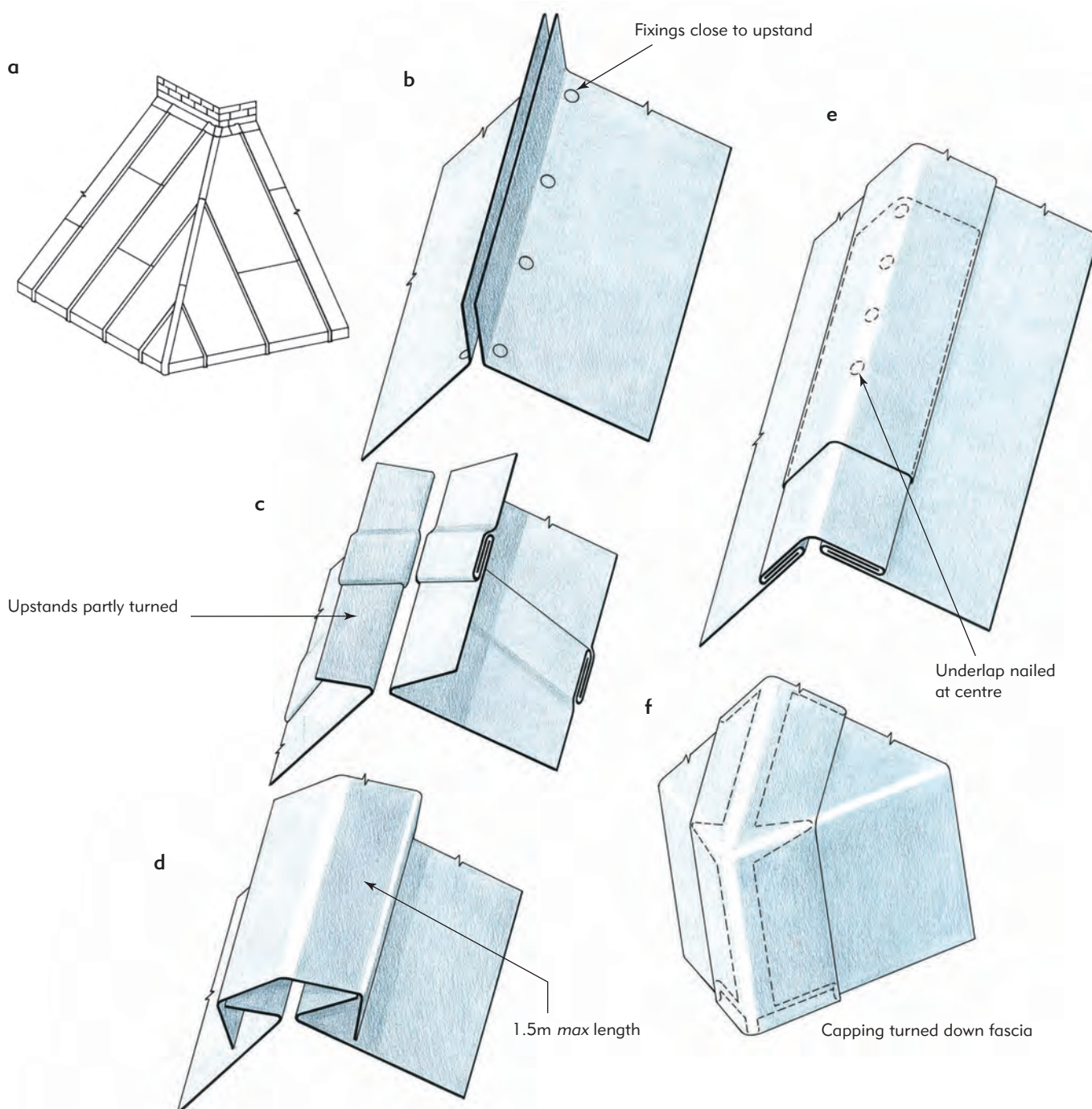
Hips (welted)

When welts are used on small areas of pitched roofing, the capping shown in Fig 245a is usually preferred. The roofing bays are turned up 25mm and nailed at 50mm centres (Fig 245b). After sealing the nail heads, the upstands are turned partly down (Fig 245c). The preformed capping shown in Fig 245d is laid over the hip and, with the aid of seaming pliers, the sides are folded under and then dressed down (Fig 245e).

Capping pieces must not exceed 1.5m in length and the top of each piece is secured with copper or stainless-steel nails. The nails are positioned near the centre of the hip to avoid penetrating the welt on each side.

At the bottom of the hip, the capping is usually turned down the fascia. To facilitate the fitting of this section of capping the underside is cut as shown in Fig 245f. The nail fixings at the top of both capping and roofing bays are normally covered by a flashing.

Fig 245. Hip/welt intersections



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°)

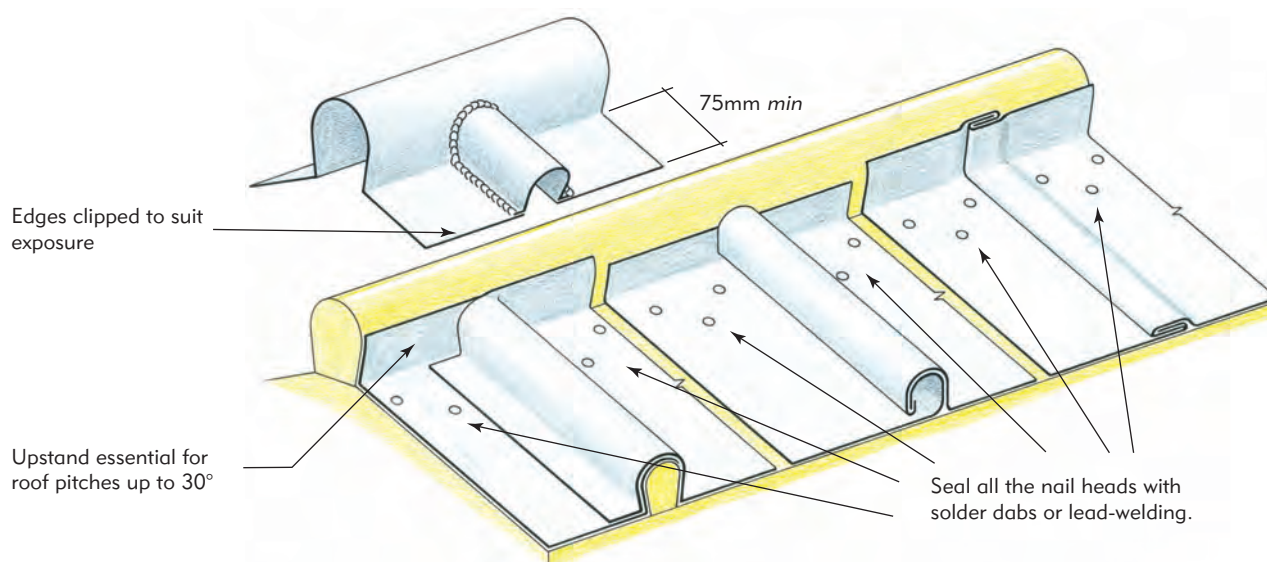
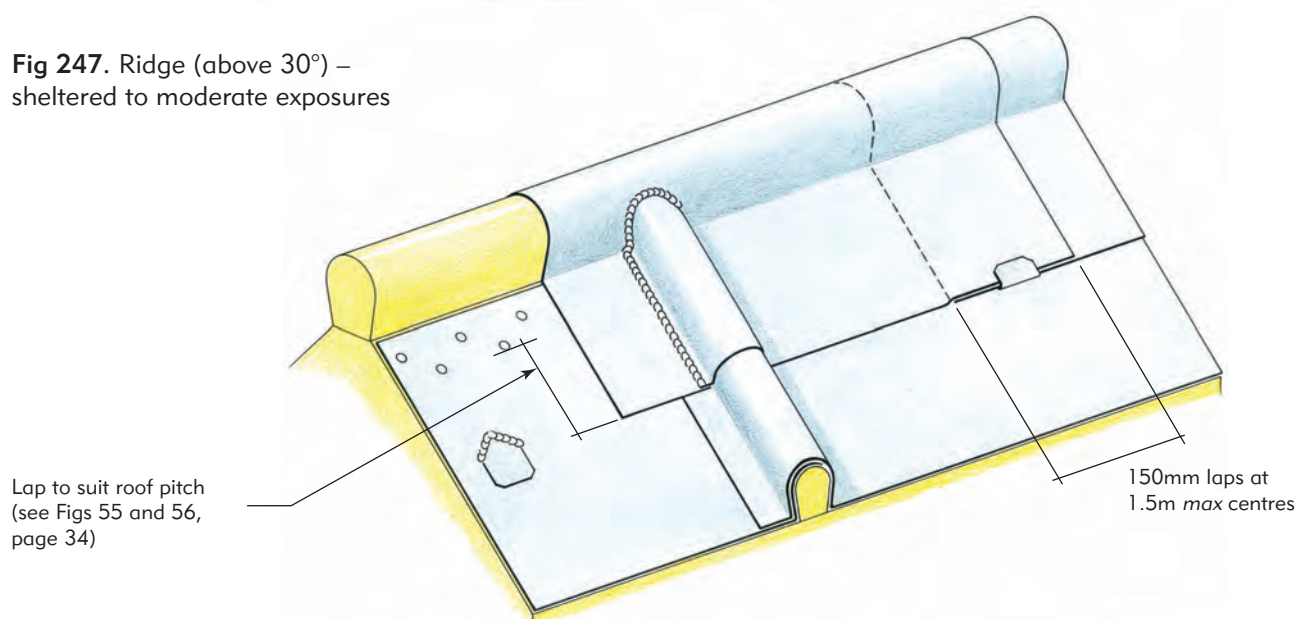


Fig 247. Ridge (above 30°) – sheltered to moderate exposures



Pitched roof coverings (cont.)

Where the hip and ridge rolls meet, the end of the ridge capping is bossed or lead-welded (Fig 248). This detail will vary slightly depending on the extension on each side of both the hip and ridge rolls.

A traditional method of detailing, used mainly when the roof covering is jointed with hollow rolls, is to carry the rolls over the ridge (Fig 249). The apex of the roof must be well rounded and at least one-third of the bay length is taken over the ridge. A gusset is inserted in the undercloak and overcloak at the ridge to suit the roof pitch.

Fig 248. Ridge/hip intersection

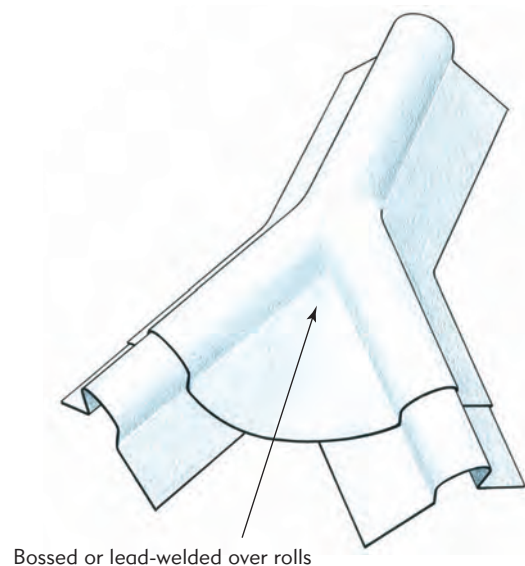
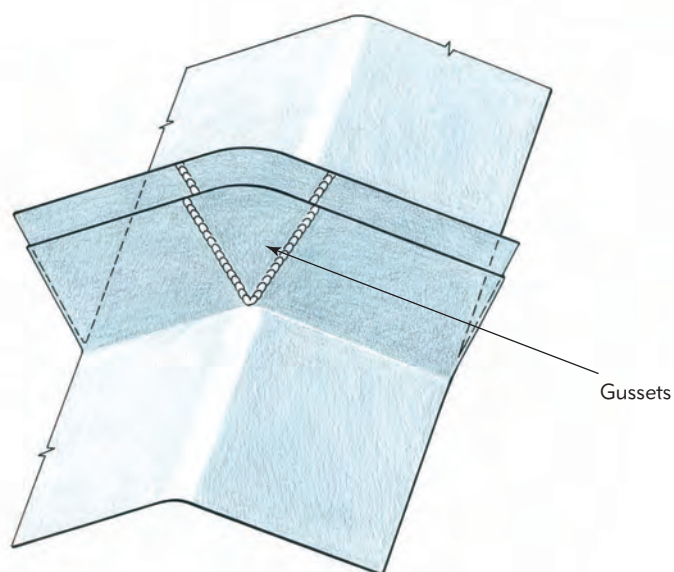
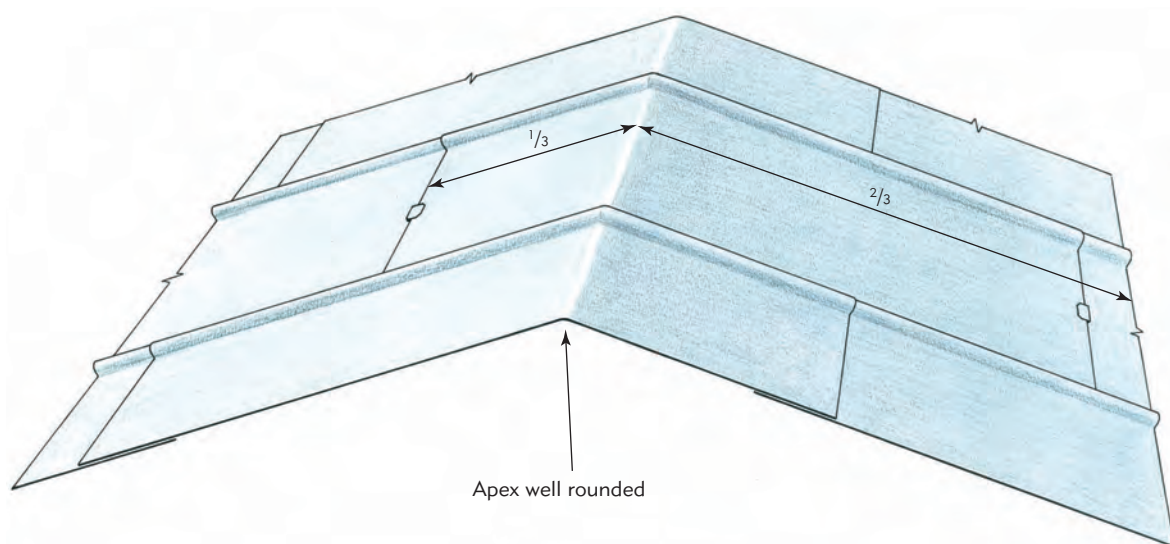


Fig 249. Rolls carried over ridge



Pitched roof coverings (cont.)

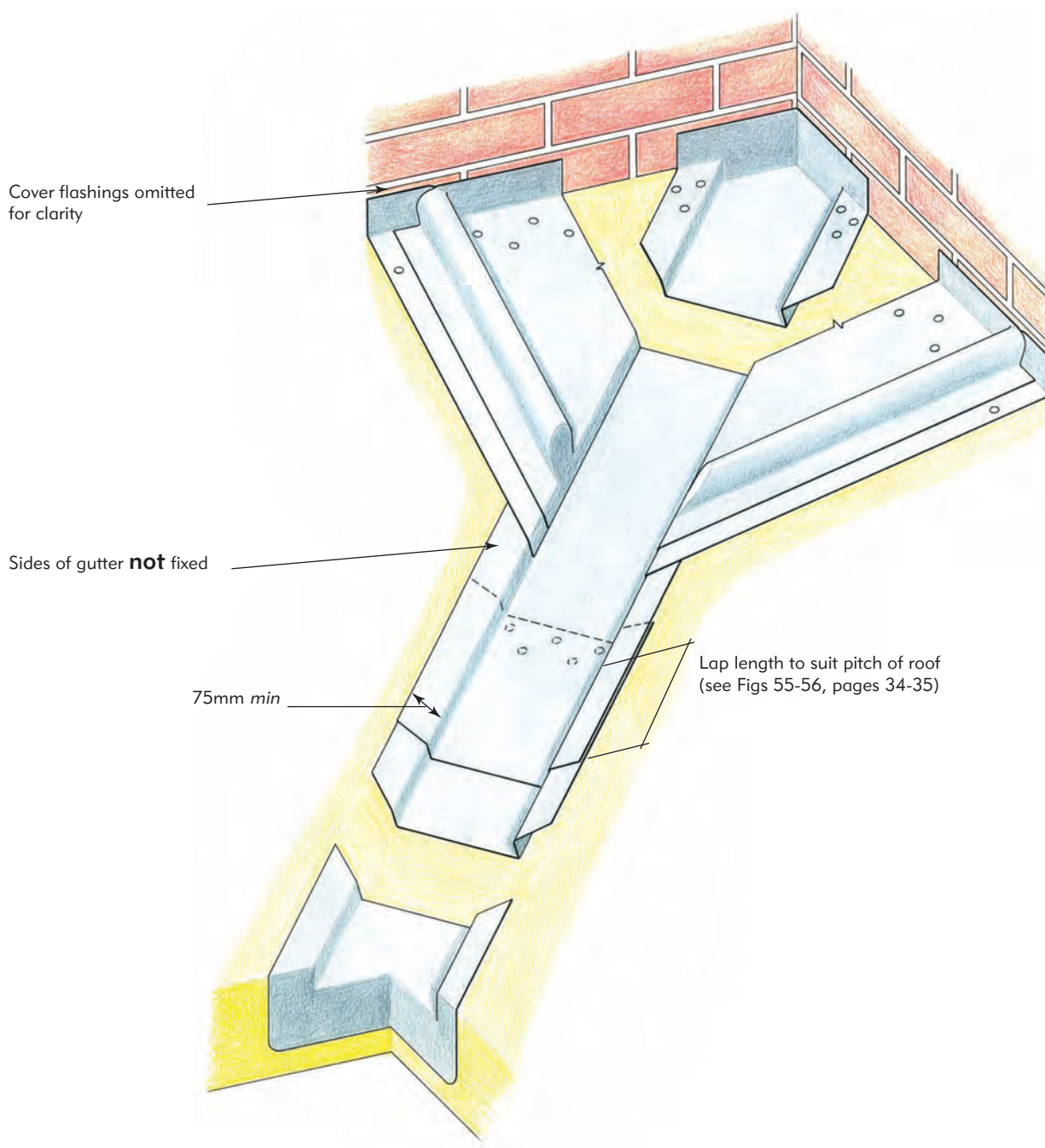
Valleys (10-20°)

This section covers the lining of valley gutters above 10°. Since the valley pitch is lower than the roof pitch, it will require a roof pitch of 15° before this section will apply. Details for valley gutter linings of 10° and below are covered in Figs 228-230 (pages 138-140). The main difference when lining valley gutters above 10° is that laps can be used instead of drips. For valleys above 10° up to about 20°, it will be necessary to construct a shallow box gutter. The depth of the gutter will depend on the size of the roof and the anticipated discharge of rainwater into the gutter.

With a gutter width of 150mm, a depth of 25mm will be adequate for most situations (Fig 250). This depth may need to be increased for large roof areas or where the gutter receives additional discharge from roof areas above.

Spacing of the laps will depend on the thickness of lead sheet used for the linings (see Tables 12 and 13, page 141). Fixings should be positioned as shown. The gutter linings should not be nailed down the sides as this restricts thermal movement of the lead and can result in premature failure.

Fig 250. Valleys (up to 20°)



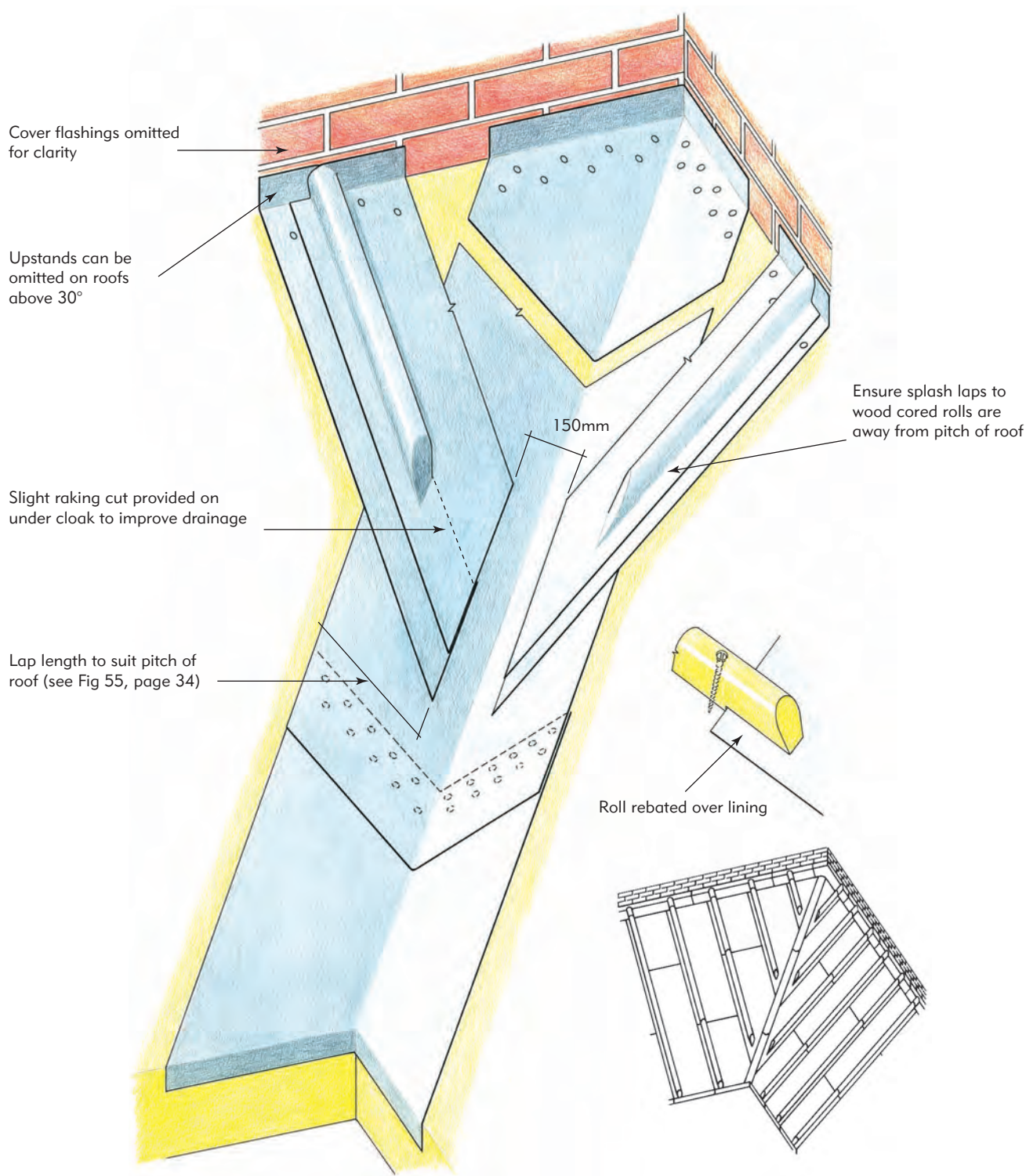
Pitched roof coverings (cont.)

Valleys (above 20°)

When lining valleys above 20°, the detail shown in Fig 251 will be suitable for most situations. However, if the roof pitch is significantly steeper on one side of the valley, there could be a risk of water penetration on the lower side. For these positions, the shallow gutter detail is therefore recommended.

Again, it is important that the sides of the lining are not fixed. To avoid this, the wood rolls should be rebated over the linings, with the lower screw positioned above the lining as shown. For spacing of laps, see Tables 12 and 13 on page 141.

Fig 251. Valleys (above 20°)



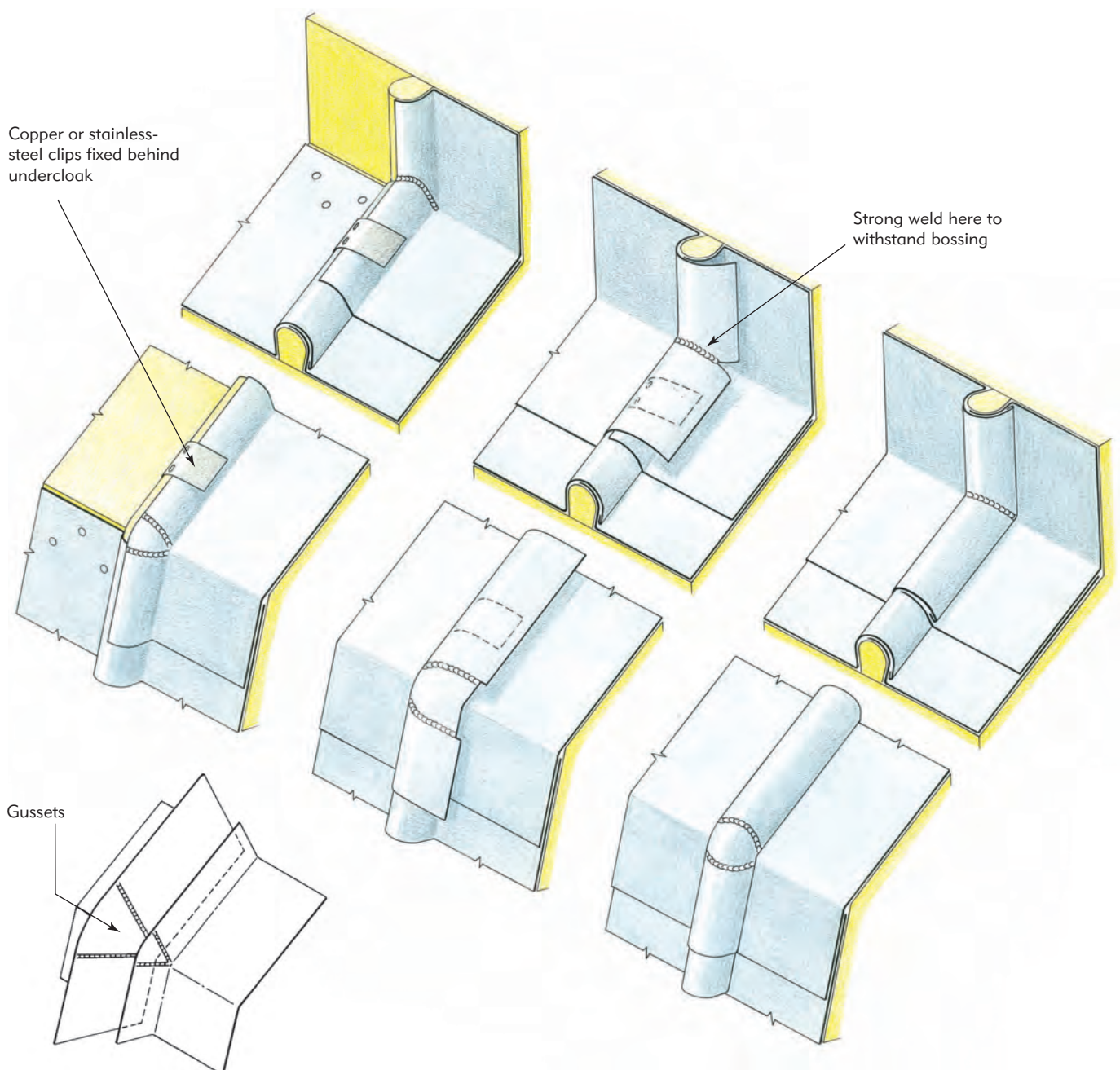
Pitched roof coverings (cont.)

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.

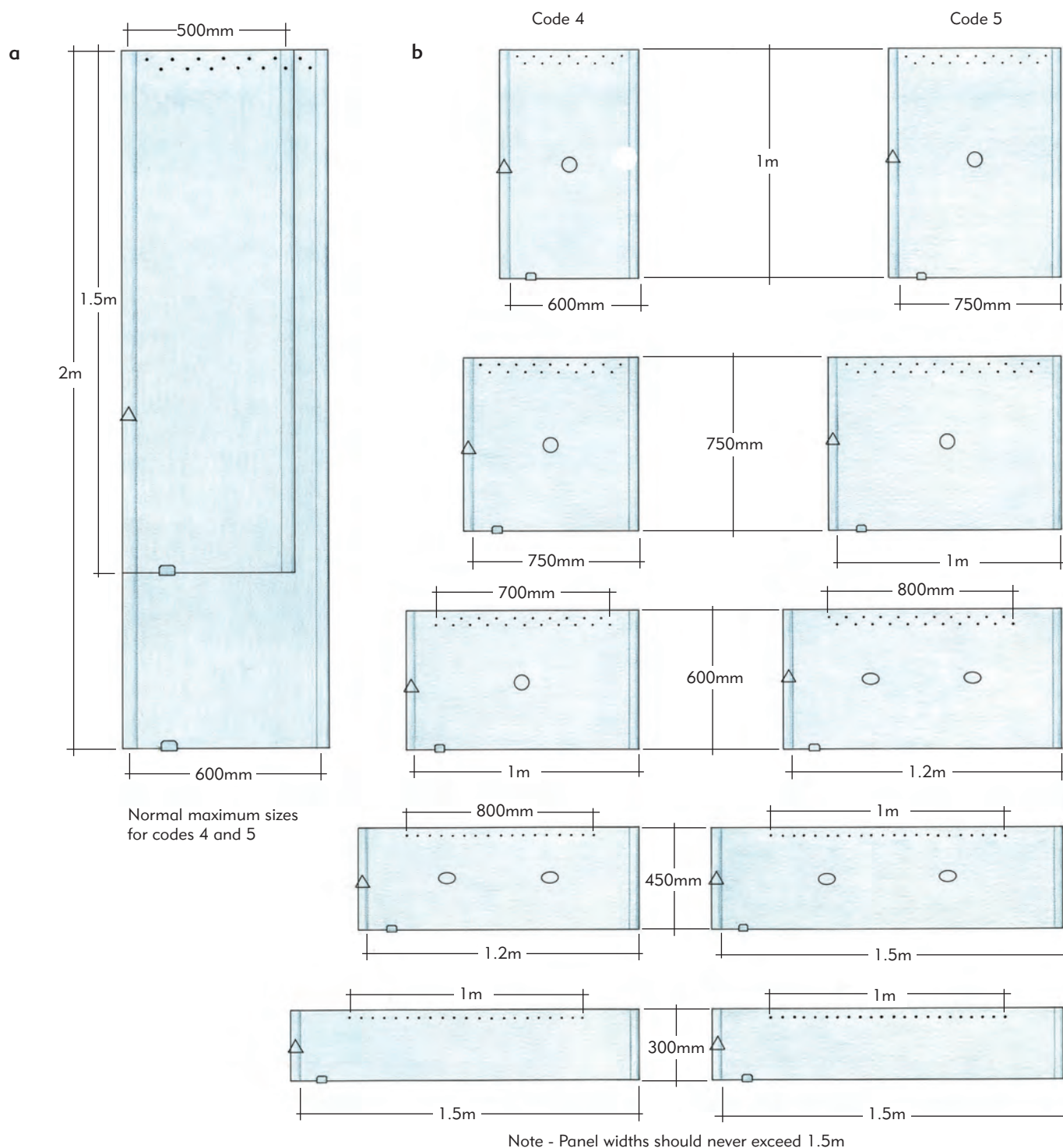
Table 14. Cladding – spacing of joints

BS EN 12588 code no	Maximum spacing of vertical joints (mm)	Maximum length (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)

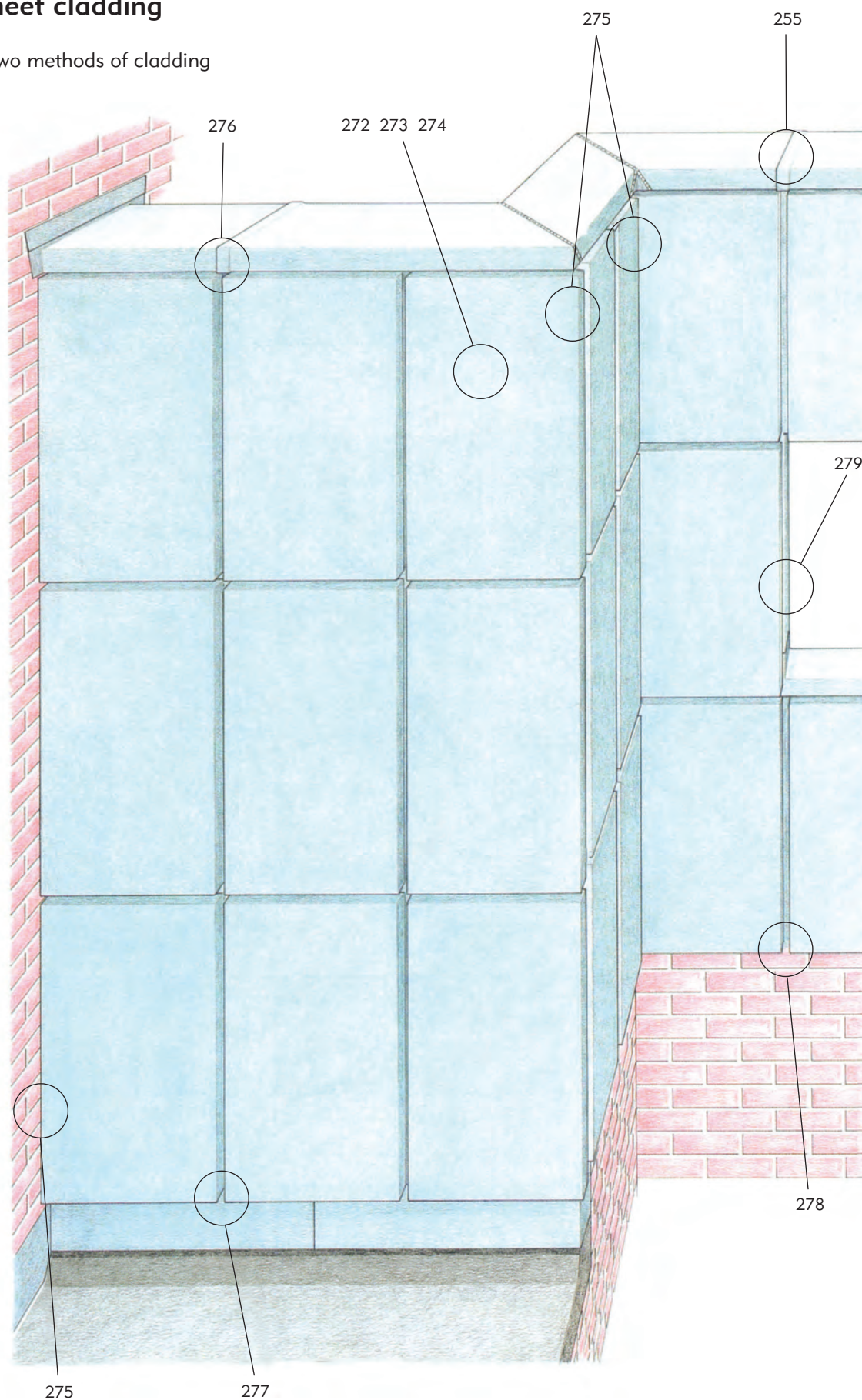
□ Fixings on free edges (see Figs 43-47, pages 28-29)

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

○ Intermediate fixings (see Fig 54, page 33)

Lead sheet cladding

Fig 254. Two methods of cladding



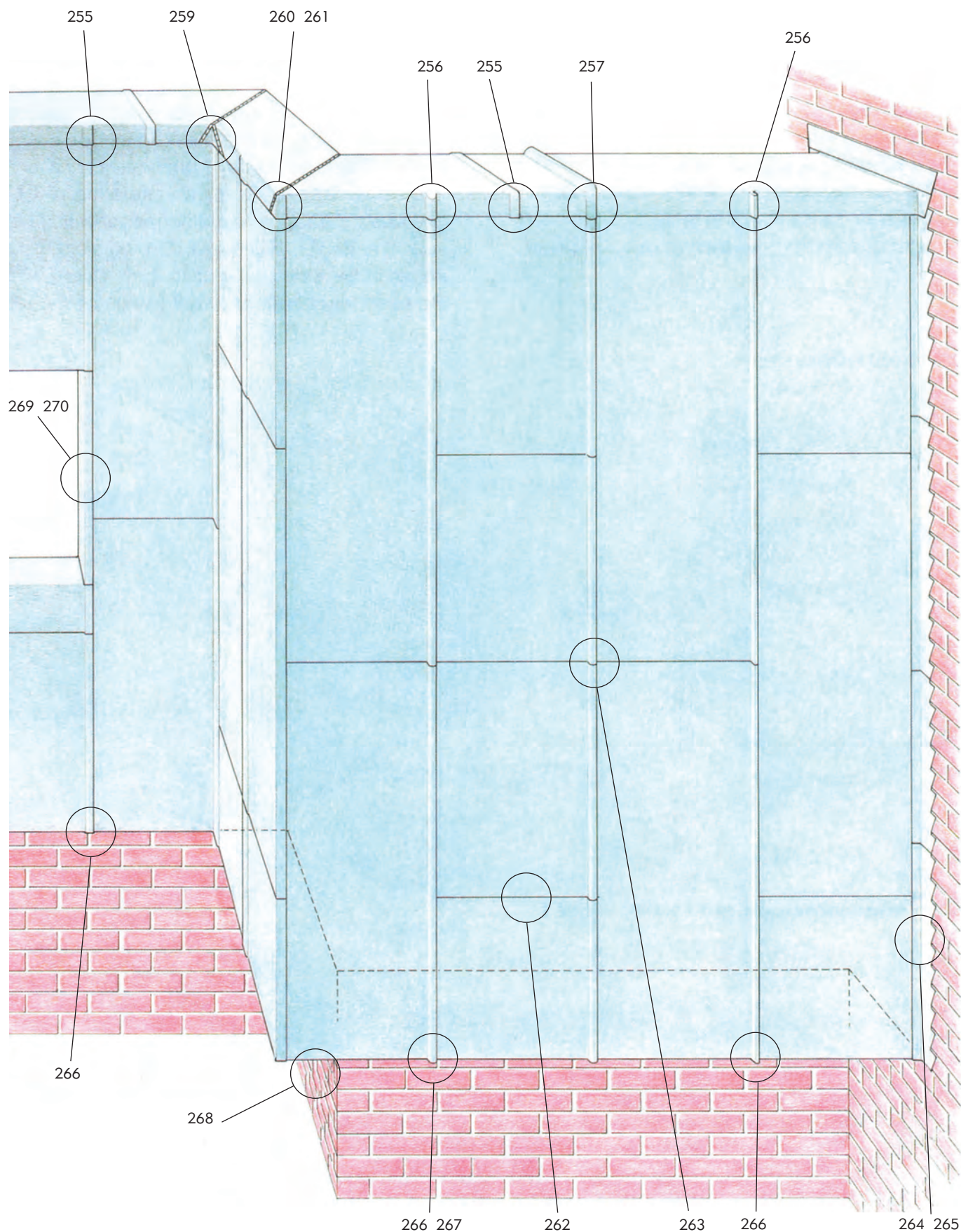


Fig 254 is an illustration showing the most common details associated with cladding fixed in-situ and with preformed lead-faced panels. The annotations indicate the figure numbers in which the relevant detail is described and illustrated.

Lead sheet cladding (cont.)

Cladding details

The details that will arise in fixing cladding include the finish at the head of a parapet wall, the finish at bottom edges, fixing to soffits, forming external and internal corners, the treatment at windows and other openings, and at abutments.

Head finishes

Where cladding finishes at the top of a parapet wall or under a window sill, the panels of lead are fixed at the head in the normal way with two rows of copper or stainless-steel nails. These fixings are weathered by a parapet capping or sill flashing, as appropriate.

The cover over the fixings should not be less than 75mm although, in exposed positions, a minimum cover of 100mm is recommended. Capping pieces are joined end-to-end with welts incorporating fixing clips. Spacing of the welts will depend on the width of the parapet wall but should not exceed 1.5m (see Table 7, page 84). Normally, for aesthetic reasons, the welts are spaced to suit the module of the vertical joints. A welt positioned in the centre of every second vertical joint is usually preferred. Figs 255 and 256 show details of head finishes for welts, standing seams and rolls. Adequate clipping along both free edges at the sides will secure the capping without the need for intermediate dot fixings on the top.

Fig 255. Head finishes – welts

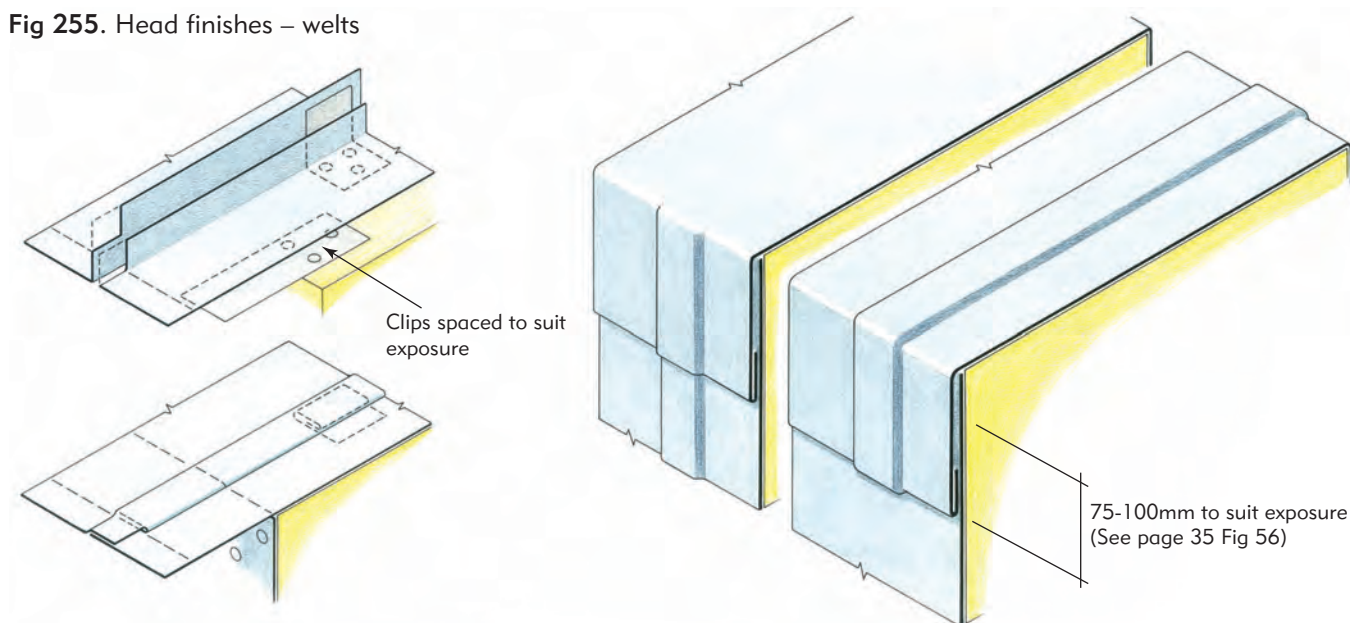
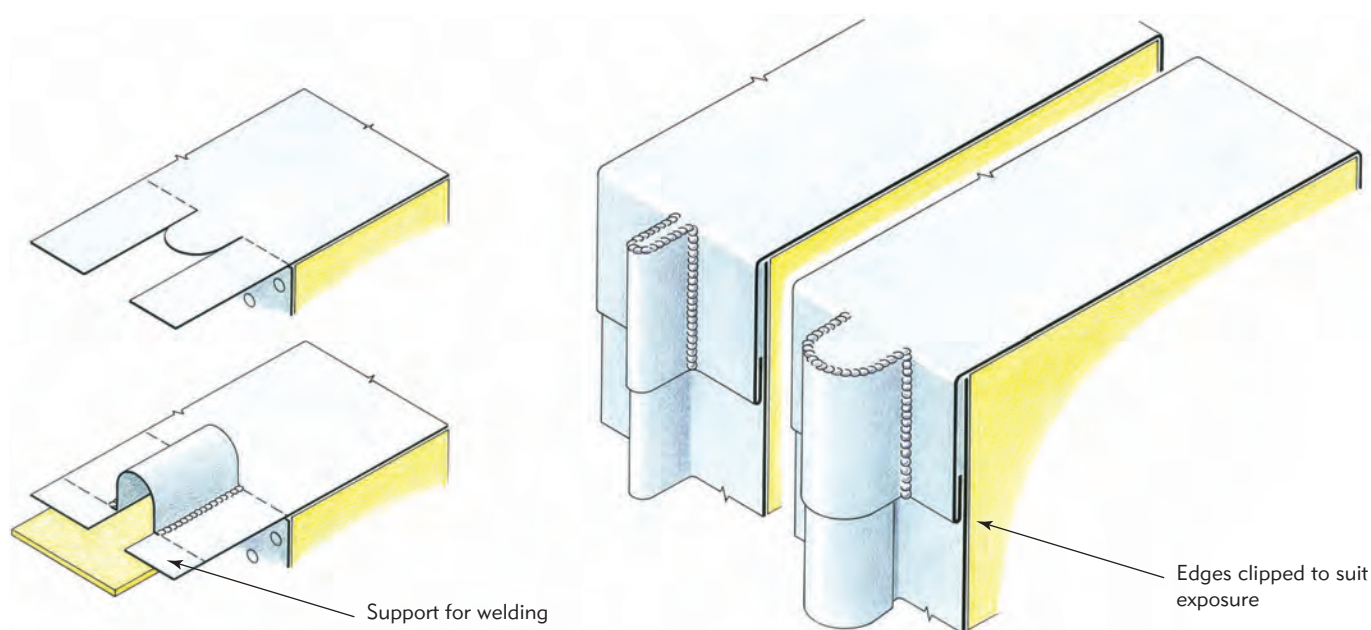


Fig 256. Head finishes – rolls and standing seams



Lead sheet cladding (cont.)

Where the welts on the capping are turned to engage clips along the free edge, some cutting away of the folds will be necessary to achieve a neat appearance. If saddle pieces over standing seams or rolls are welded in-situ, they can be supported in the horizontal position as shown. The top can then be welded after the lead has been turned down.

If wood-cored rolls are carried across the top of a wall, the capping pieces are made to suit the roll spacing. The undercloak is nailed to the roll and the overcloak secured with clips (Fig 257). These capping pieces can be made entirely by bossing or, more usually, by part-bossing and part-welding. Detailing an angle in a wood-cored roll has been previously described (Fig 252, page 156).

Fig 257. Head finishes – rolls (alternative)

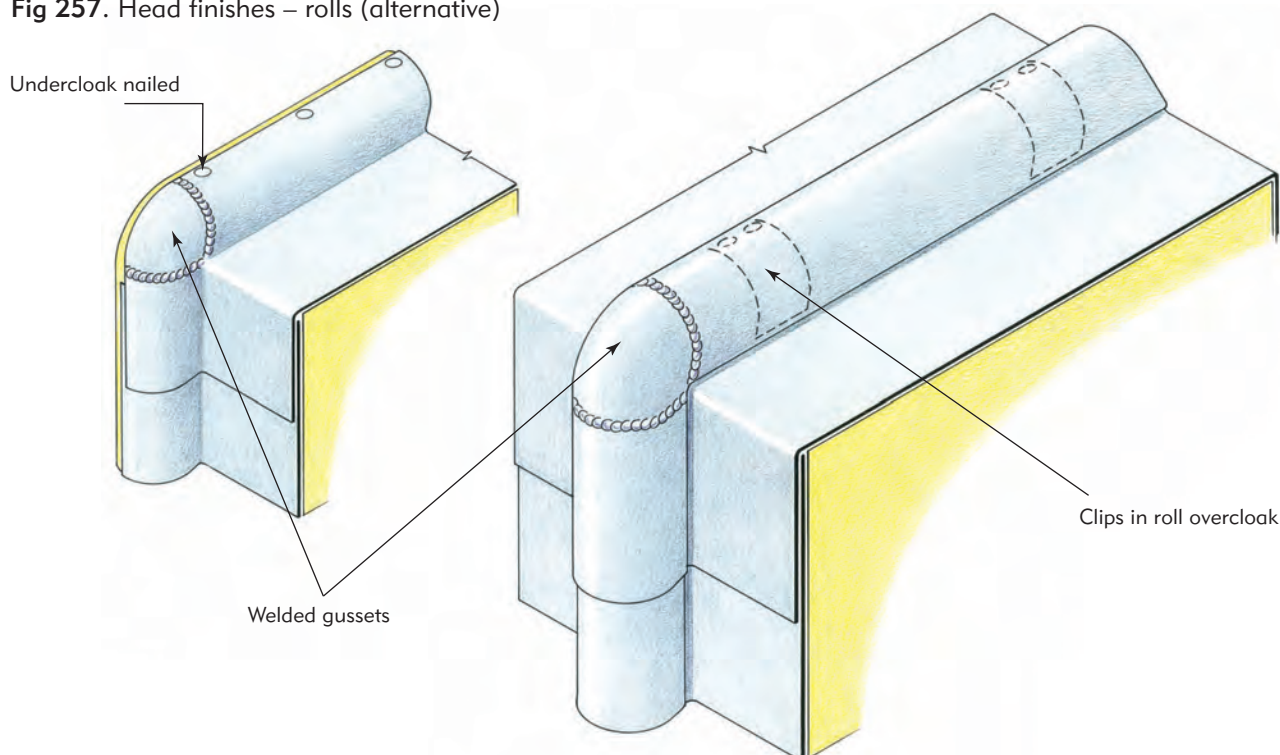
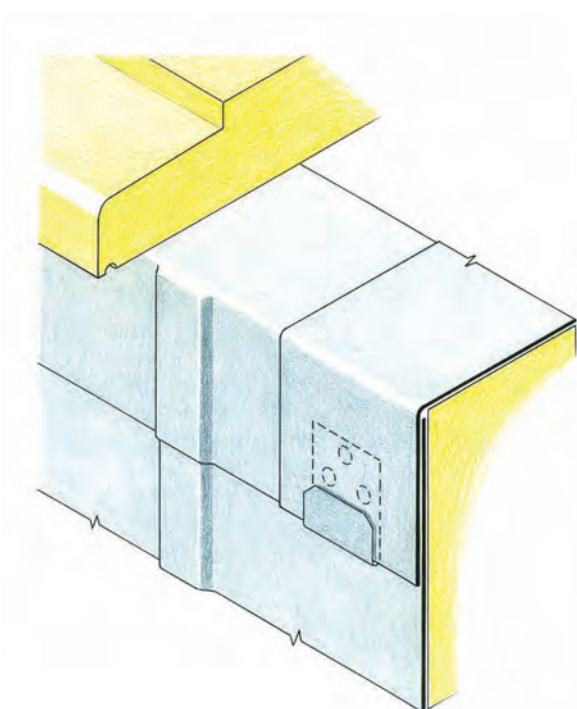


Fig 258. Finish under sill



Cladding finishing under a window is normally weathered by a sill flashing (Fig 258). This flashing is continuously fixed along one side by the weight of the window, and therefore it is important that the flashing lengths are not longer than 1.5m – or 1m if the cladding receives long periods of direct sunlight. Laps between pieces should be 100-150mm depending on the exposure of the building.



Lead sheet cladding (cont.)

Corners

At corners, it is preferable to arrange the cladding panels so that there is a vertical joint at the angle. This will allow freedom for thermal movement on both faces at the change in direction, while being secured at the corner by the clips in the welts or rolls (Figs 259 and 260).

Normally the parapet capping is welded at both internal and external angles and the corners are formed as shown.

Where a roll is used on an external corner, the saddle piece at the top has an allowance on one side to facilitate the welding of the corner with an inclined seam and avoid an in-situ upright weld (Fig 261).

Fig 259. Internal corner

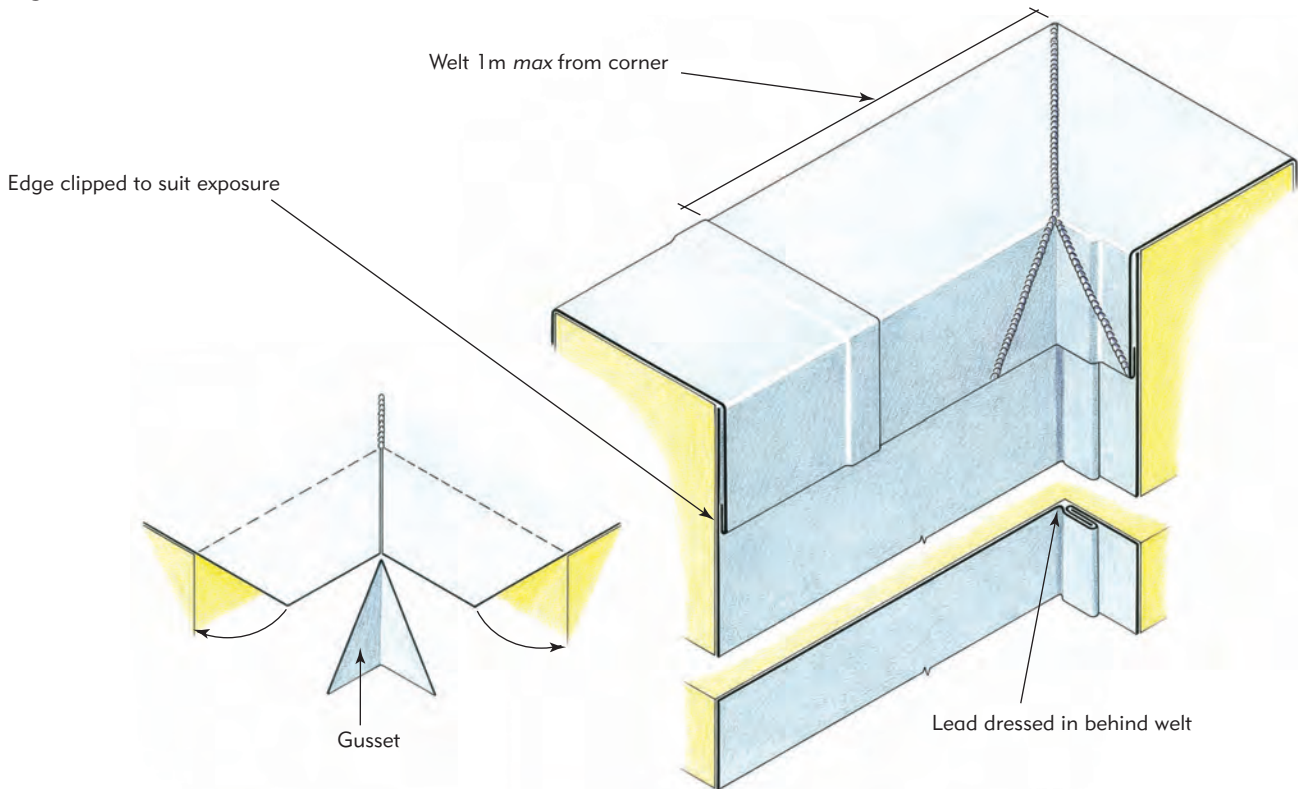
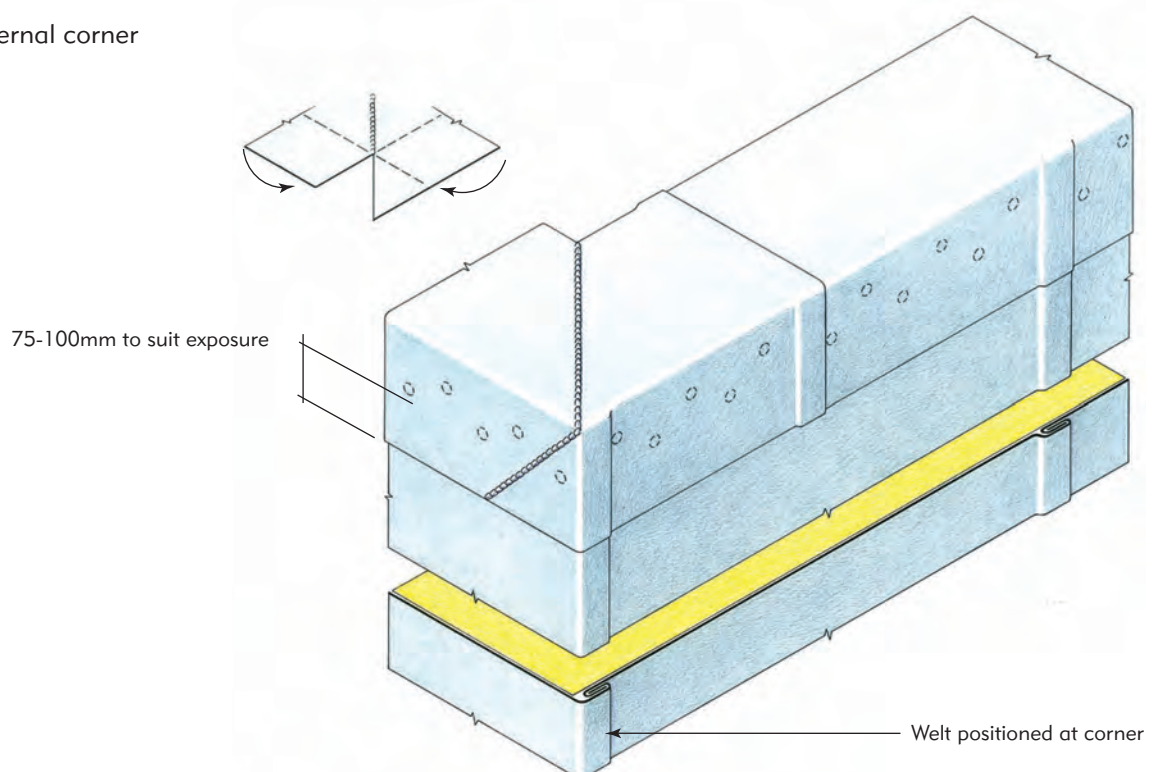
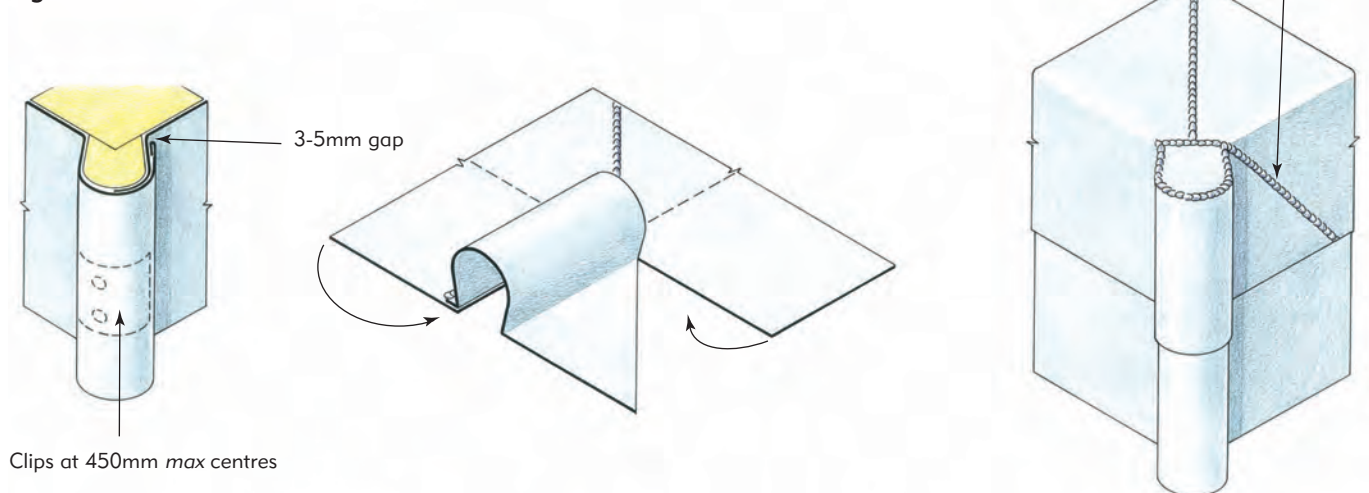


Fig 260. External corner



Lead sheet cladding (cont.)

Fig 261. Roll at corner

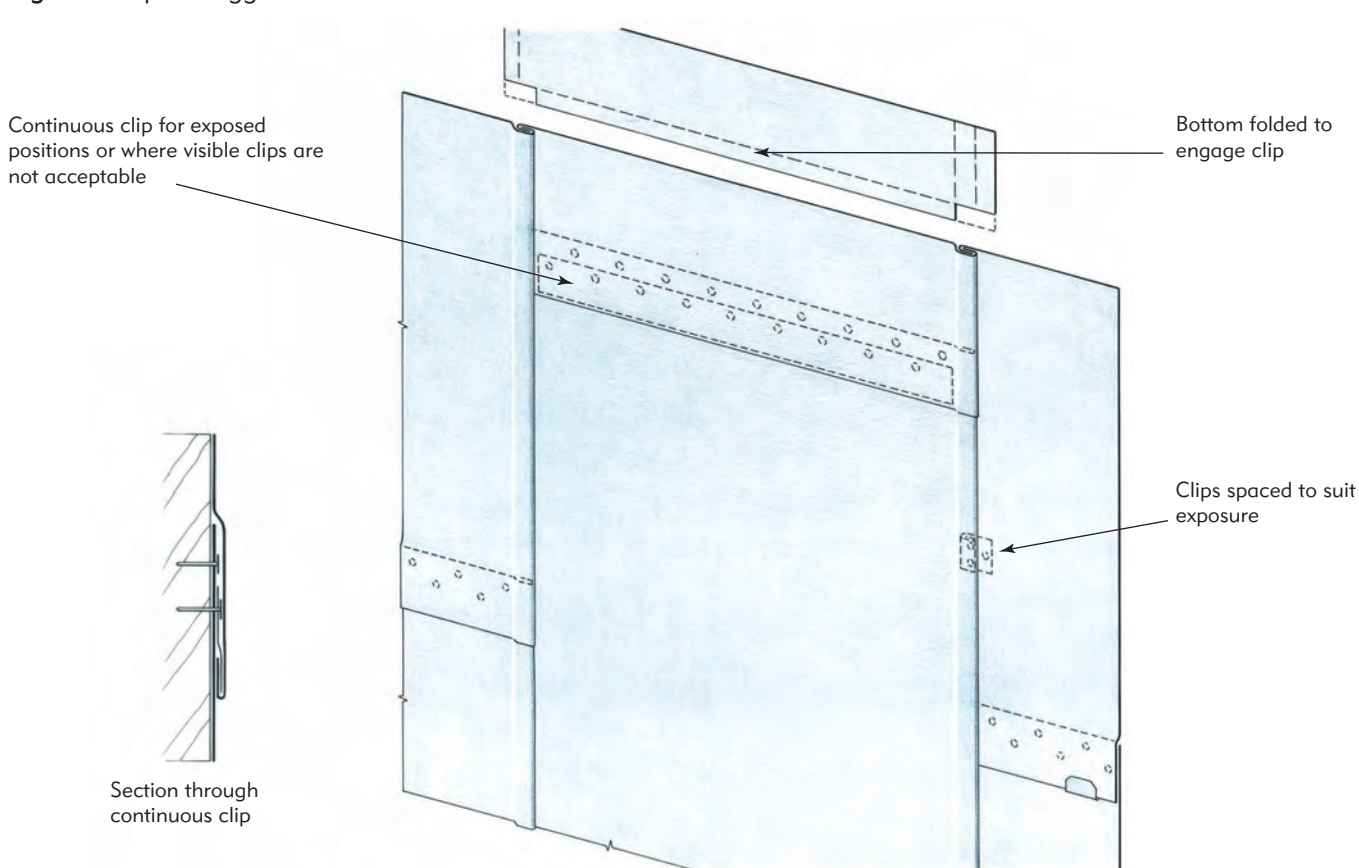


Laps

Horizontal joints in lead cladding are laps which are usually staggered from bay to bay to avoid a build-up of thickness where they intersect with the vertical welts or rolls (Fig 262). However, there are situations where laps in line are desirable for aesthetic reasons, and Fig 263 shows how parts of the welt overlap can be cut away to achieve an unobtrusive but still weather-tight finish at the intersection. For an example where laps are in line and the vertical joints are rolls, see Fig 234 (page 145).

To cover the fixings and provide a weather-tight joint, the minimum lap should be 75mm. In exposed positions, a 100mm lap is recommended, and in very exposed situations, it may be necessary to increase it to 150mm. Clips will be required on the overlaps to suit the exposure or, alternatively, the overlaps can be single-welted around a continuous clip. The bottom edge of the overlaps is turned before the panels of lead are positioned for fixing. The continuous clips can be copper or stainless steel and the welted edge extends for the distance between the inside of the vertical welts or rolls. This method of clipping is suitable where visible clips on the overlaps are undesirable and where there is a high risk of wind uplift at the laps in exposed positions.

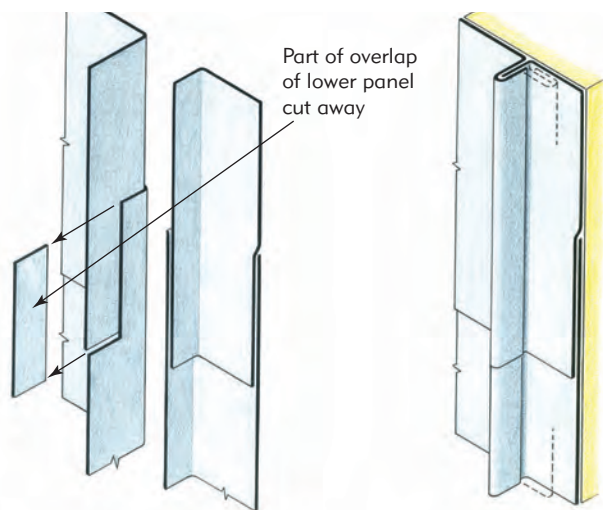
Fig 262. Laps - staggered



Lead sheet cladding (cont.)

Laps

Fig 263. Laps in line



Abutments

Where lead cladding abuts a wall, the work should be finished and secured at the abutment with a welted joint. This is formed by fixing a separate strip of lead to the substrate to provide the overlap (Figs 264a, b and c). When required, a wider strip of lead can be built into the wall to provide a vertical DPC. In both cases, a strip of metal is inserted into the angle during the forming of the welt to prevent damage to the surface of the lead. When the abutment is brickwork, it can be finished with a step flashing. The edge of the cladding is secured in the normal way with copper clips (Fig 265a). The flashing is marked to suit the joints in the brickwork and then cut and folded out of position (Fig 265b). After positioning the flashing in the brickwork, the welt is dressed down and the flashing wedged and pointed (Fig 265c).

Fig 264. Welt at abutment

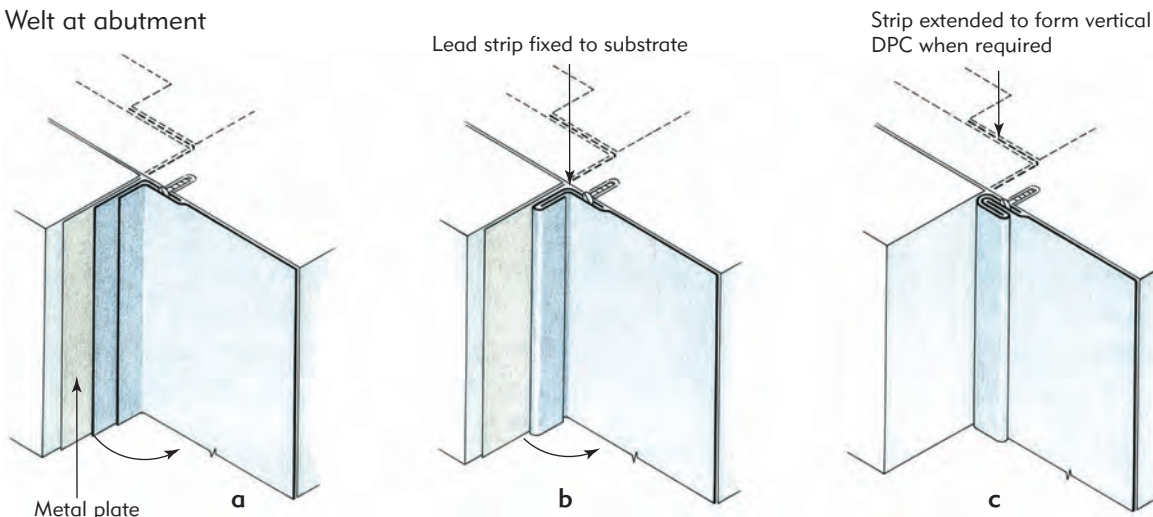
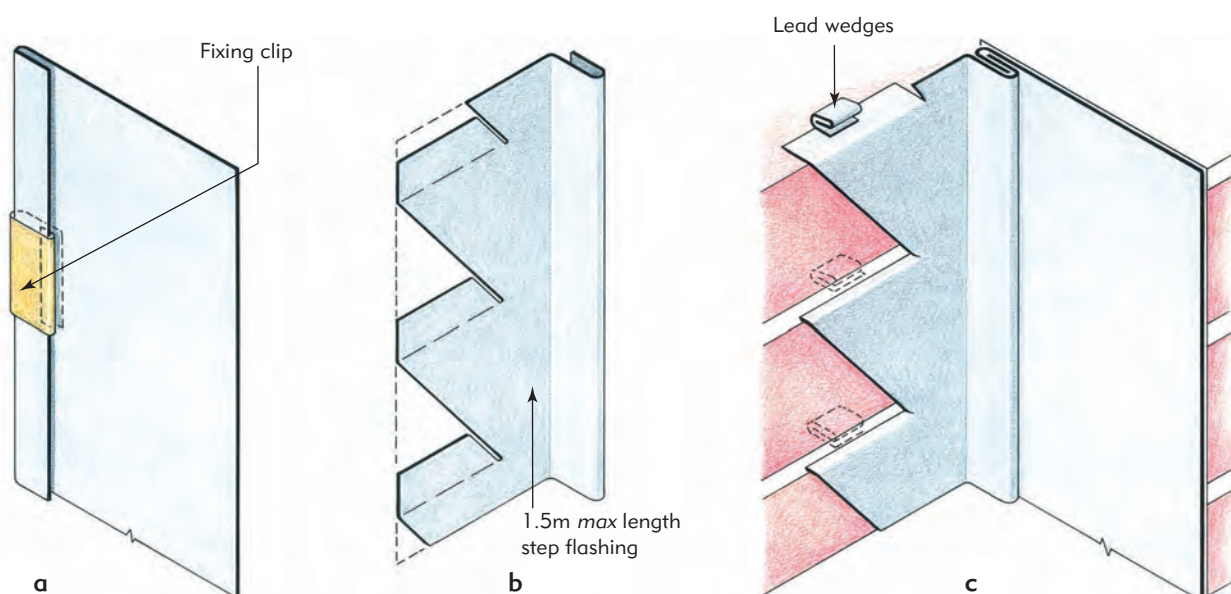


Fig 265. Step flashing at abutment



Lead sheet cladding (cont.)

Bottom edges

The most practical way to finish the bottom of an area of lead cladding is to turn the lower edge of the cladding panels around a continuous stainless-steel or anodised-aluminium angle. The angle provides a firm, continuous fixing, is suitable for all exposures, and achieves a straight edge along the bottom of the cladding. Fig 266 shows the finish for the wood roll, hollow roll, standing seam and welt. The end of a wood roll is normally bossed since it would be very difficult to weld a roll end in this position. Hollow rolls and standing seams are left open.

However, the usual practice for a welt is to cut away the thicknesses of lead, as shown, before turning the edge to engage the continuous clip.

For situations where restricted space makes it impractical to boss wood-cored roll ends, it is possible to preform the roll ends using lead-welding (Fig 267a). Laps between the preformed pieces are provided in every second bay and the lower panels of cladding should finish not less than 6mm above the retaining clips to allow for expansion (Fig 267b).

Fig 266. Finishes at bottom edge

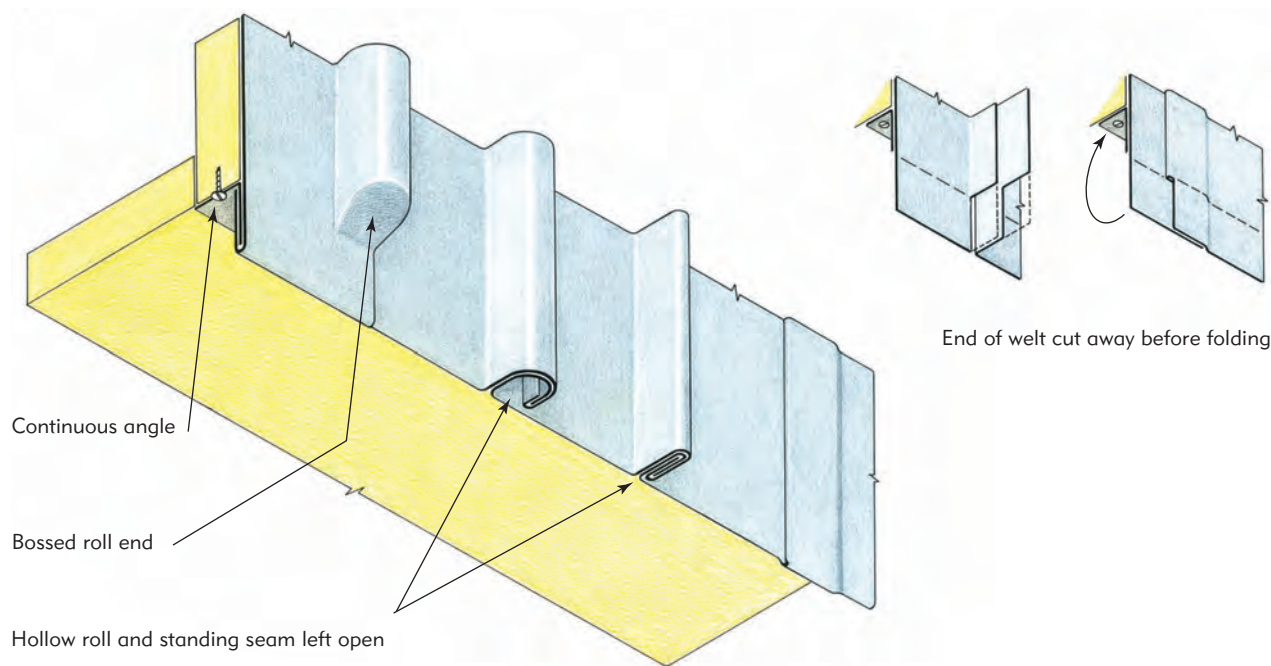
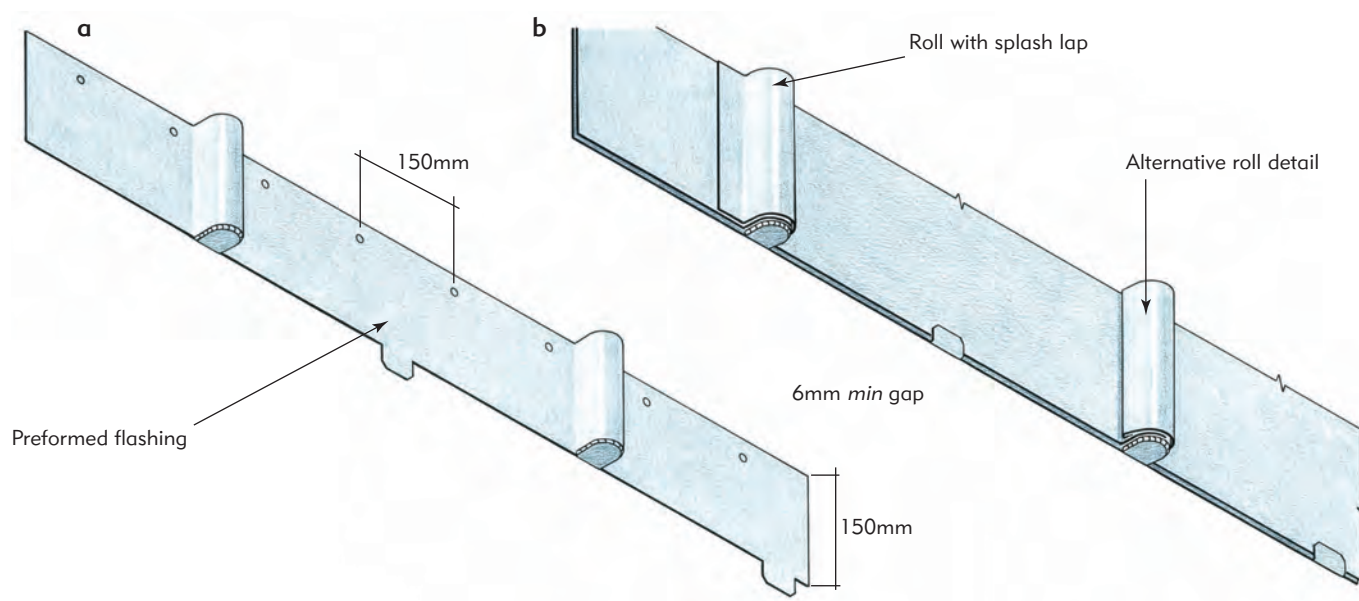


Fig 267. Alternative finish to bottom edge



Lead sheet cladding (cont.)

Soffits

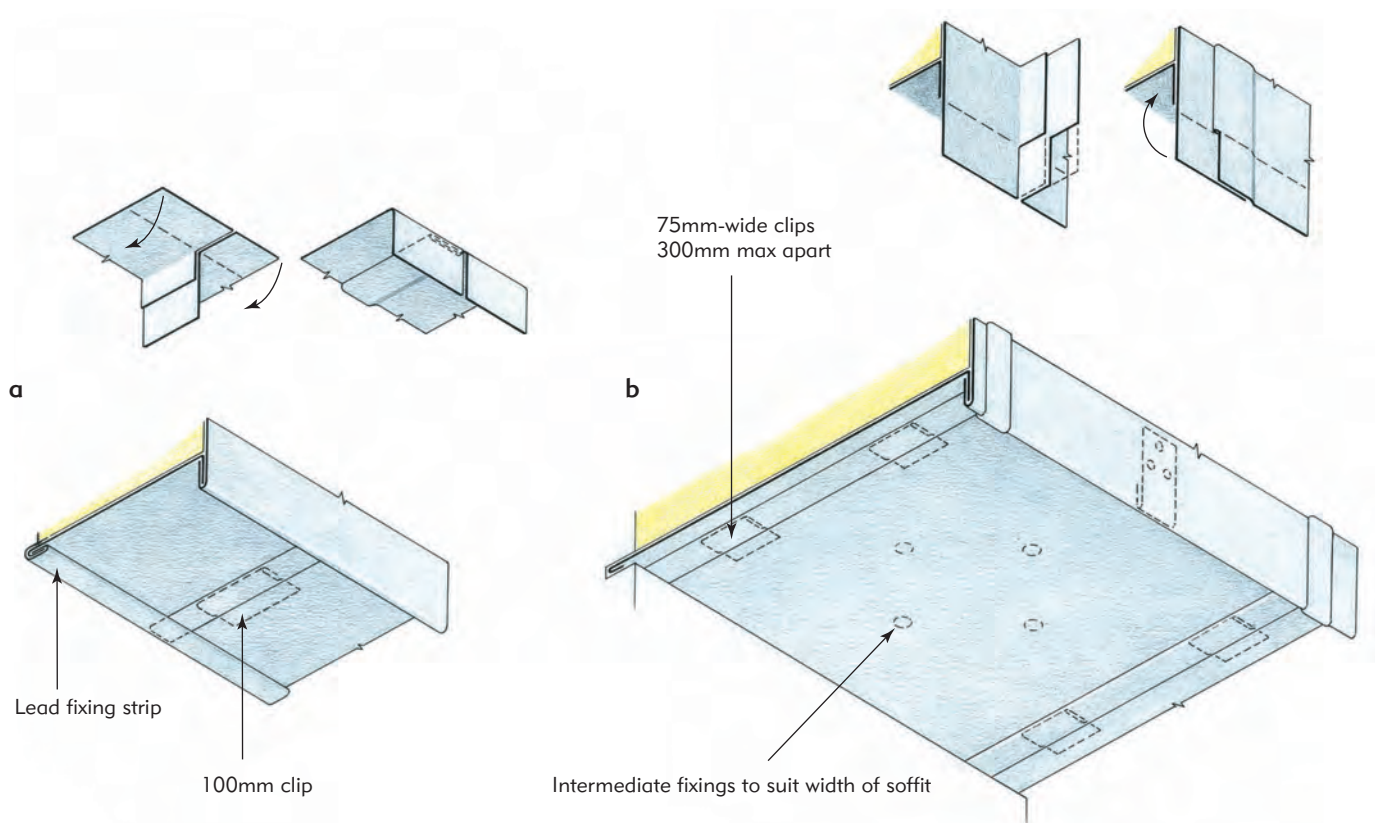
Although lead cladding can be fixed to soffits and surfaces that slope inwards from the vertical, more support will be required to offset the natural tendency for the lead to sag away from the substrate. The number and frequency of the fixings and joints required will depend on the width of the soffits.

For widths up to 150mm using code 4, or widths up to 200mm using code 5, the soffit linings can be fixed end-to-end with welts that occur midway between or in line with the vertical cladding joints. A convenient spacing of these welts would be 1m for code 4 or 1.2m for code 5. This narrow soffit lining will be held in position by fixing 100mm-wide copper clips in the end-to-end welts, by incorporating copper clips in the drip edge, and by building in the back edge or fixing the back edge with a continuous lead strip welted to the soffit lining. Where welts in the soffit linings or vertical cladding are turned to form a drip edge, parts of the folds can be cut away, as shown (Fig 268a).

Where a soffit exceeds 200mm in depth, the length of the lining pieces should be reduced to a length corresponding to the bay width of the cladding above – for example, 500mm for code 4 and 600mm for code 5 (Fig 268b). The number of intermediate fixings required to prevent the soffit panels from sagging between the welts will depend on the width of the soffit and the thickness of lead sheet used. For a soffit up to 400mm, at least two intermediate fixings will be required, and for a 600mm-deep soffit, at least four fixings will be necessary, as shown. With very deep soffits, the intermediate fixings should be positioned so that there is not more than 150mm between fixings when using code 4 or 200mm for code 5.

Lead cladding of inward sloping areas should be fixed in the same way. The frequency of clips in the joints and the spacing of intermediate fixings should be adjusted to accommodate the angle of the slope. This may occur when cladding the lower part of an oriel window or where vertical wall cladding is designed to finish with an inward sloping area at the bottom.

Fig 268. Soffits



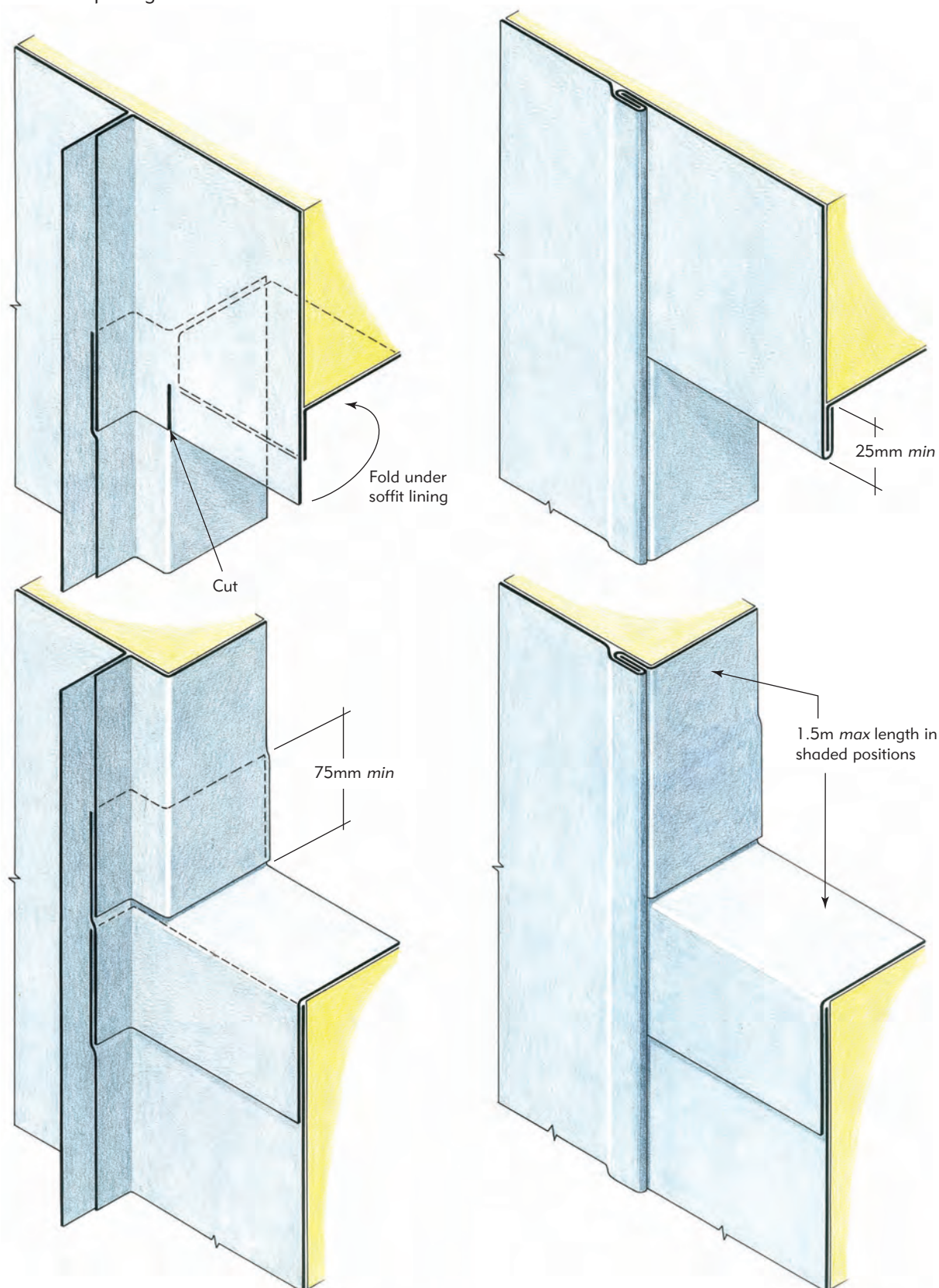
Lead sheet cladding (cont.)

Windows and other openings

A vertical joint should be positioned on each side of a window or other opening in an area of lead cladding. Details of the sill and head corners when using welts are shown in Figs 269 and 270.

When using rolls for the vertical joints, the detailing is similar to welts, although the allowances for undercloaks and overcloaks are greater (Fig 271).

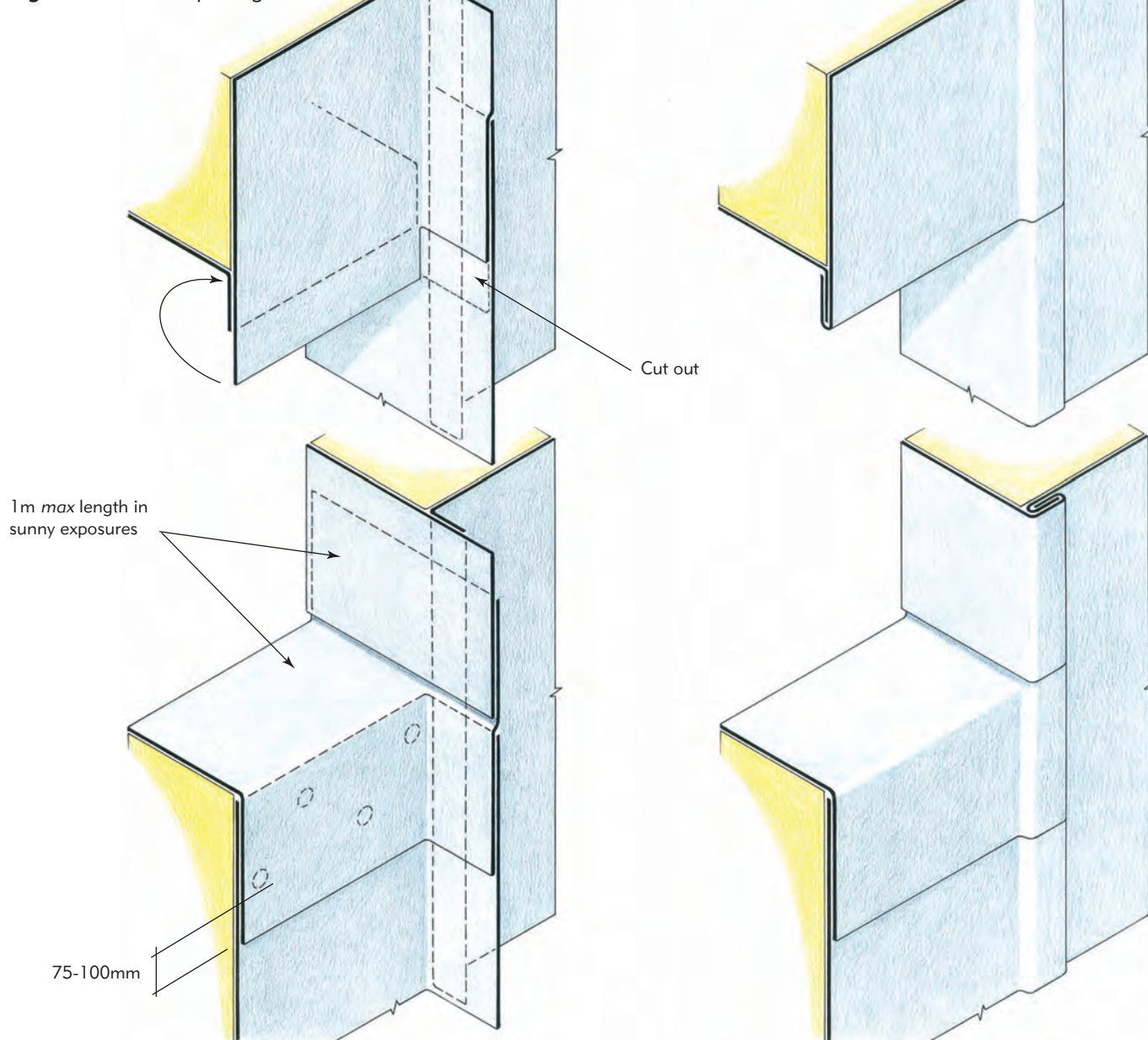
Fig 269. Welts at openings



Lead sheet cladding (cont.)

Windows and other openings

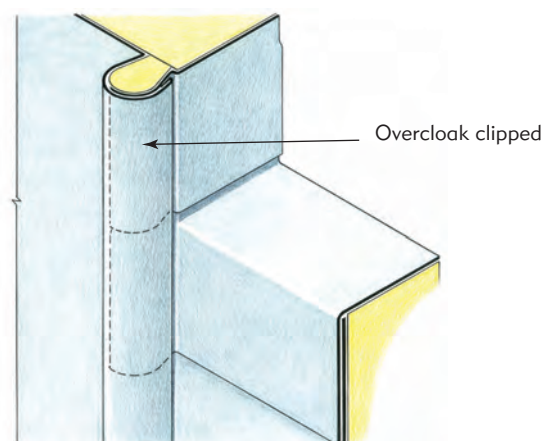
Fig 270. Welts at openings



It should be noted that the welts on each side of the opening are turned in the same direction. Although both welts can be turned either towards or away from the opening, changing direction is not recommended because the joints will appear aesthetically different, especially when the cladding is in full sunlight.

In most cases, the cladding on the sides of the opening and the sill flashing will be firmly secured by a window or ventilation grille. It is important, therefore, that the jamb and sill sections are not longer than 1.5m, or 1m if the cladding is subject to long periods of direct sunlight. Laps between sill sections should be 100-150mm (depending on the exposure) and laps between jamb pieces not less than 75mm.

Fig 271. Rolls at openings



Lead sheet cladding – preformed

An alternative to the traditional method of in-situ lead cladding is to preform lead-faced panels in a workshop and then fix them to the outside of a wall or frame construction. Preformed cladding has the advantage of a shorter site time than traditional cladding, and the appearance of the finished leadwork can be more easily controlled.

Panel size

Fig 253 (page 158) shows the maximum panel sizes for codes 4 and 5, which are the thicknesses of lead sheet commonly used for this work. Where panels are required to line up with window mullions or to suit the module of a building, they can be designed with intermediate fixings, as shown. However, unless essential for design purposes, the panels are best made to dimensions where intermediate fixings are not required. For example, a code 5 panel 1.2m long x 600mm deep requires two intermediate fixings as shown. If two 600mm x 600mm panels were used, the intermediate fixings would not be required. There is always the tendency, particularly in very sunny exposures, for intermediate fixings to cause unevenness in the lead surface and so reduce the quality of the finish.

Making the panels

The material most commonly used for the panels is 20-25mm-thick exterior-quality plywood. Occasionally, a fire-resistant building board may be required to comply with local regulations. To reduce the risk of warping, some designers specify painting the back of the panels to prevent moisture absorption.

Plywood panels are not normally braced at the back to protect against warping, but designers may think this is necessary in some situations. In all cases, the provision of ventilation behind the panels should be considered.

To make a panel, a piece of lead sheet is cut to suit the length and width required, with an additional 75mm all round. If a board thicker than 25mm is used for the backing material, the allowance should be increased accordingly. The lead sheet is placed, with the best face down, onto a flat-top bench covered with canvas or cloth to protect the face of the lead against scratches or indentations.

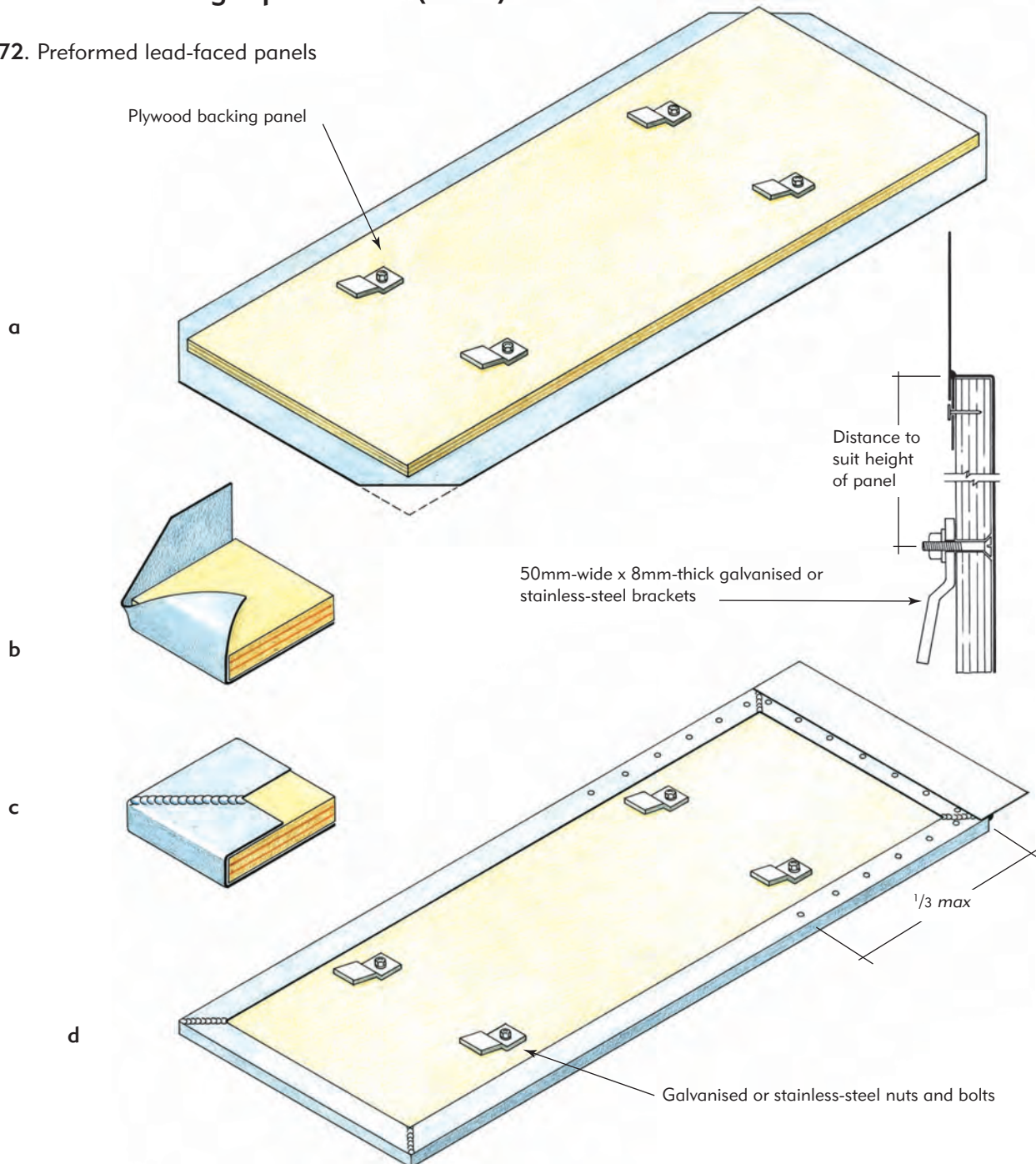
After dressing flat, lines are marked on the lead to determine the position of the plywood and, allowing 12-15mm for bossing, the four corners are cut off at 45°. If a secret tack intermediate fixing is required, it will be welded to the back of the lead at this stage (Fig 52, page 32). In addition, a slot will be required in the plywood with the face recessed to allow for the thickness of the lead tack.

Before the plywood is placed in position on the lead facing, four galvanised or stainless-steel bolts with countersunk heads are inserted through holes in the face of the plywood. Experience has shown that if the holes are drilled to a diameter slightly smaller than that of the bolts, the action of screwing the bolts will pull the countersunk heads into the face of the timber to provide a flush finish (Fig 272a). The four galvanised or stainless-steel fixing brackets are then bolted to the back of the plywood.



Lead sheet cladding – preformed (cont.)

Fig 272. Preformed lead-faced panels



With the plywood in position (Fig 272a), the lead is folded up the sides and the small corners bossed (Fig 272b). The sides are folded onto the back of the plywood and the mitres at the corners welded with flat butted seams (Fig 272c). The lead is then fixed with a row of copper or stainless-steel nails 75mm apart across the head and not more than one-third down each side (Fig 272d). Where preformed panels require intermediate fixings (Fig 254), the nailing across the top of each panel is similar to that shown, except that in all cases only one row of nails is required. If the cladding consists of more than one row of panels, or the top is to be finished with a capping, as shown in Fig 276, it will be necessary at this stage to weld a 125mm-wide strip of lead sheet to the top of each panel.

Where a large number of preformed panels are required, consideration should be given to providing mechanical aids to speed up production. A compressed-air nailing gun and a swivelling steel former for turning the sides of lead over the plywood are examples that have been used successfully in the past.

Lead sheet cladding – preformed (cont.)

Fixing the panels

Preformed lead-faced panels can be fixed to the exterior of a frame construction, where there is access from behind the panels, by bolting the panels directly to the frame. In these cases, the offset fixing brackets will not be required because the bolts through the plywood will provide the fixings to the frame. However, the more usual requirement is for preformed panels to be fixed from the outside to the structural wall.

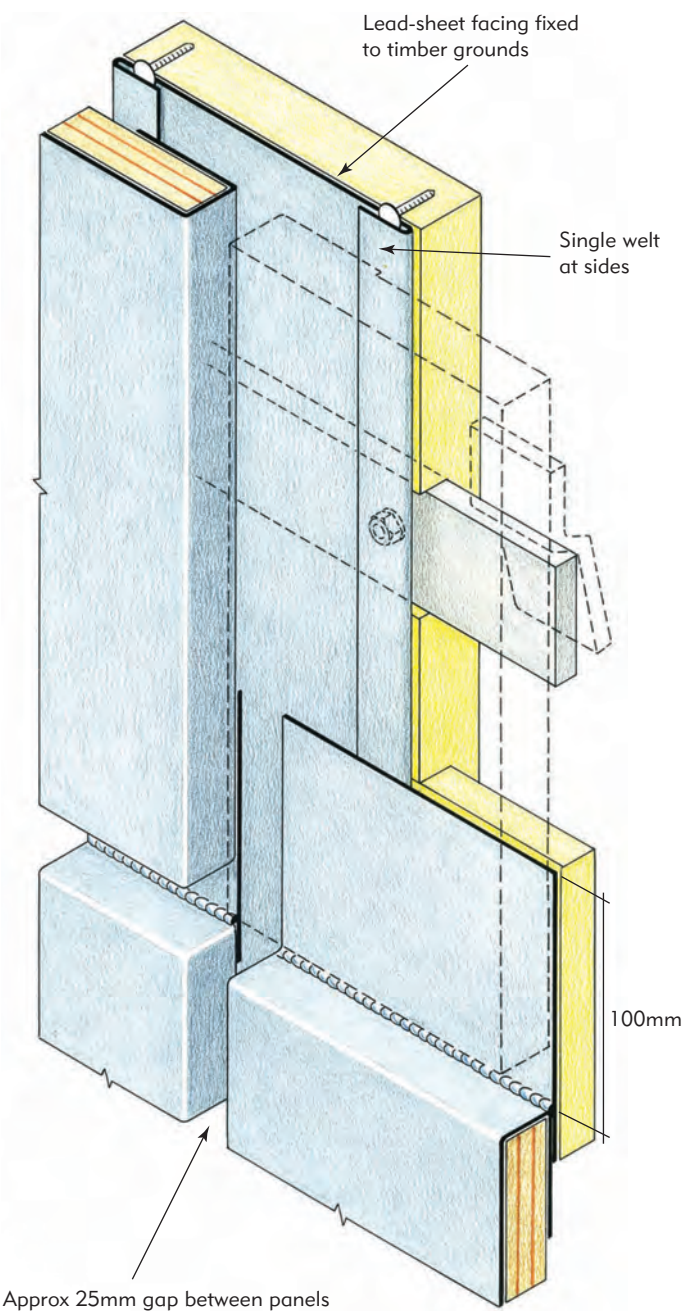
A method of fixing to solid walls is shown in Figs 273 and 274. Vertical timber grounds about 150mm x 40mm are fixed to the structure at the spacing of the vertical joints. It is important to ensure that these timber grounds are shimmed out where necessary to achieve a true face, otherwise it will be difficult to engage the lead panels. Horizontal battens about 125mm x 25mm are then recessed and fixed into the vertical grounds, as shown, with their spacing dependent on the horizontal joint spacing of the cladding.

Fixing of the galvanised or stainless-steel support bars is very important since these will take the weight of the cladding. The size of bars will depend on the size of the cladding panels and the thickness of lead sheet used. Normally 50mm x 10mm will be adequate but some designers may prefer to increase this to 75mm. The usual method of fixing the bars is with wall anchors. Holes are drilled through the vertical grounds into the structure and, after placing the anchors in position, the bars are bolted through the grounds into the anchors. This method provides a strong fixing for both the support bars and the timber grounds. Spacing of the bars will depend on the position of the fixing brackets on the back of the panels, which in turn will be governed by the size of the panels.

The next stage is to face the timber grounds with lead sheet fixed in lengths of about 1.5m, with laps not less than 75mm. The top third of each 200mm-wide facing strip is nailed to the timber and the sides of the lead are then turned to form a single welt to protect against the ingress of driving rain.

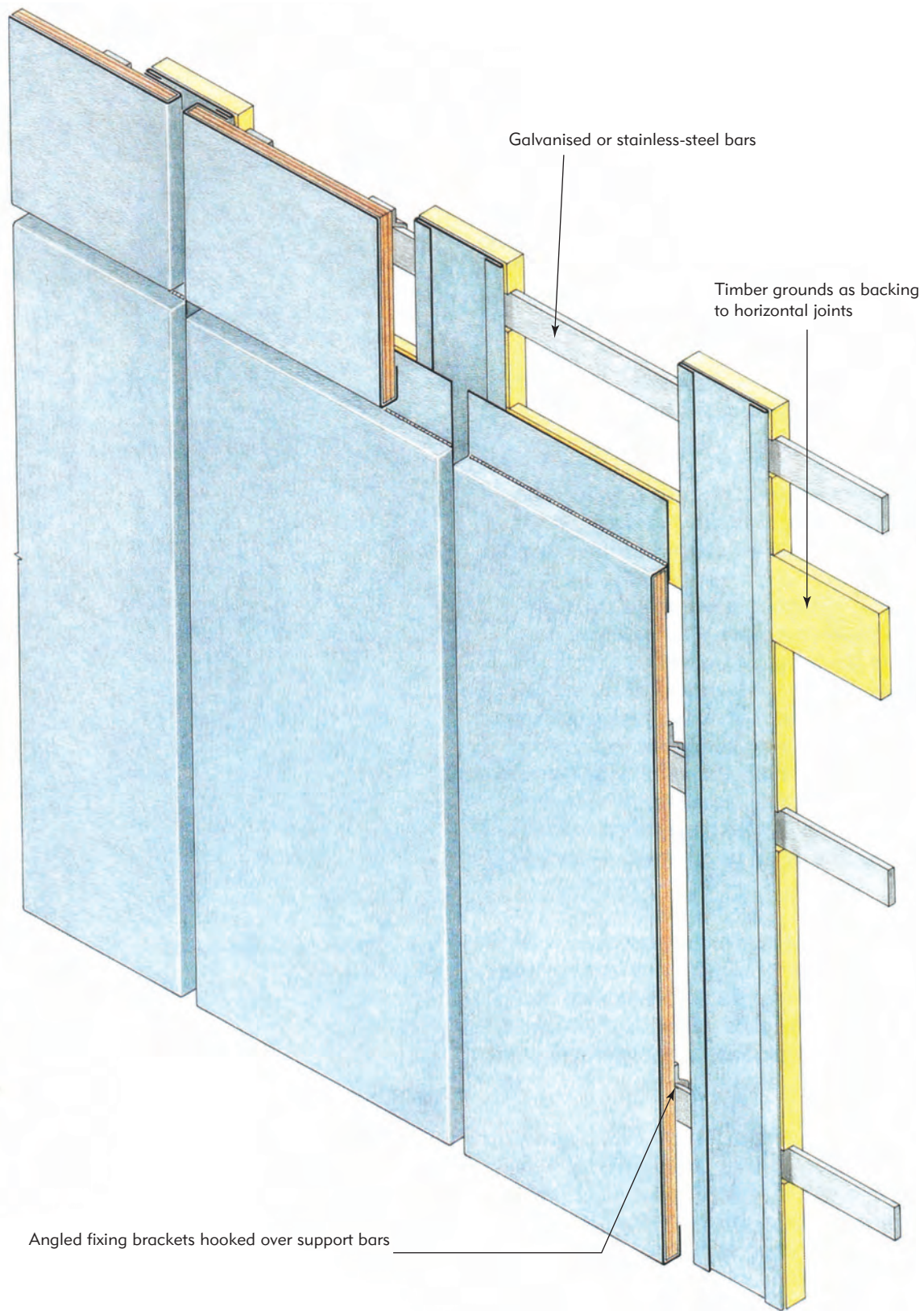
Mounting of the panels is relatively easy if the groundwork has been carefully aligned. Note that the fixing brackets on the panels are angled away from the back to make engaging the panels to the support bars easier. As the panels are pushed down over the bars, the angled brackets will pull the panels close to the lead-faced grounds to provide a firm fit. The panels should not be butted tightly together, since this would impede thermal movement. For this reason, it has become the normal practice to leave a gap of about 25mm, both vertically and horizontally, between the panels.

Fig 273. Fixing the panels



Lead sheet cladding – preformed (cont.)

Fig 274. Panels mounted in position



Lead sheet cladding – preformed (cont.)

Corners and abutments

At corners and abutments, the vertical grounds can be adapted to provide a weather-tight finish. Typical examples are shown in Fig 275.

Top and bottom finishes

Where panels finish at the top of a wall, the welded upstands on the panels are usually covered by the wall capping (Figs 276 a and b). The welts that join the lengths of capping are positioned to line up with the vertical joints between the panels.

If the bottom panels finish over a flat roof, a cover flashing should be provided over the roof upstand, with the panels finished as in Fig 277. This method of finish will allow the roof covering to be renewed without removing the lead cladding. A similar finish above brickwork is shown in Fig 278.

Window and other openings

Typical details are shown in Fig 279. Where a sill flashing exceeds 1.5m in length, laps or welts (as appropriate) should be introduced to line up with a joint in the cladding. To allow the panels below the sill to be hooked onto the support bar, they should be fitted before the sill flashing. Alternatively, the jamb linings should be finished 50-75mm above the sill, as shown, so that the sill flashing can be lifted during the fitting of the panels below. If the length of the jamb linings exceeds 1.5m, laps will be required with a minimum vertical cover of 75mm. It is important to weld in a gusset at the top of the jambs, as shown, otherwise wind-driven rain will be able to penetrate at these corners.

Fig 275. Corners and abutments

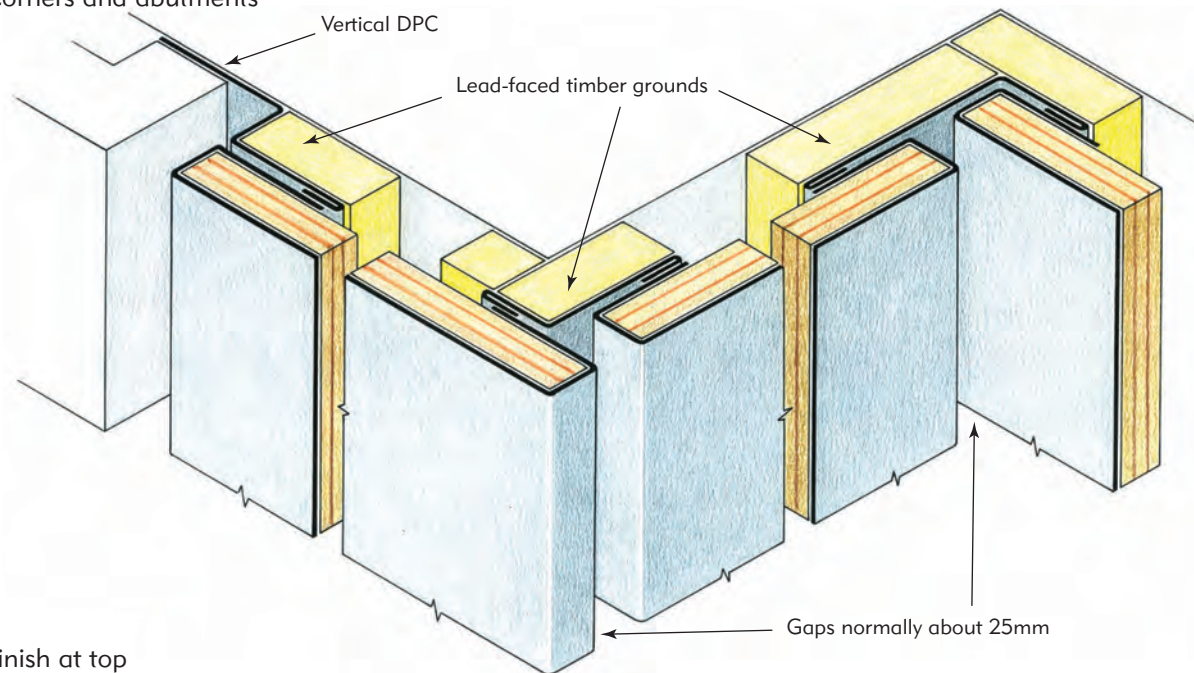
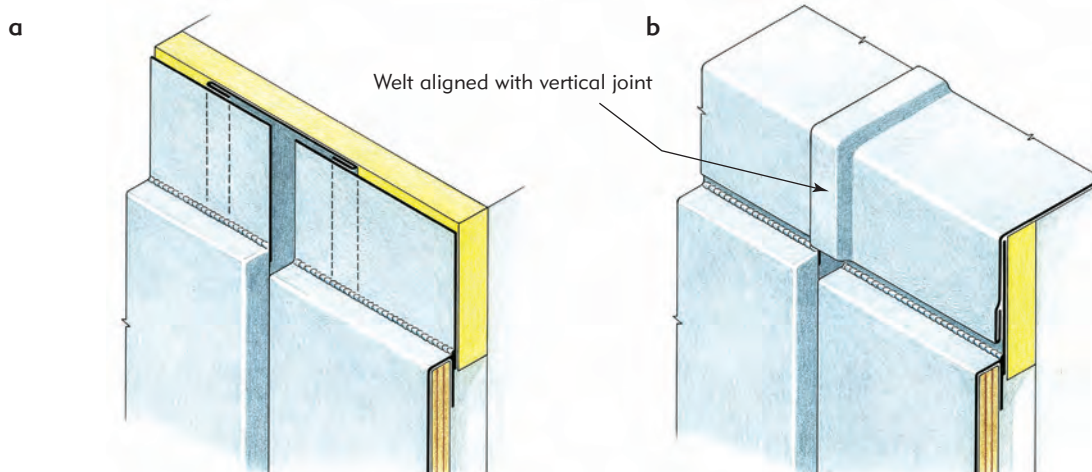


Fig 276. Finish at top



Lead sheet cladding – preformed (cont.)

Fig 277. Junction of cladding with flat roof

Flashing turned up to allow renewal of flat roof covering when required

Lead facing extended over flashing

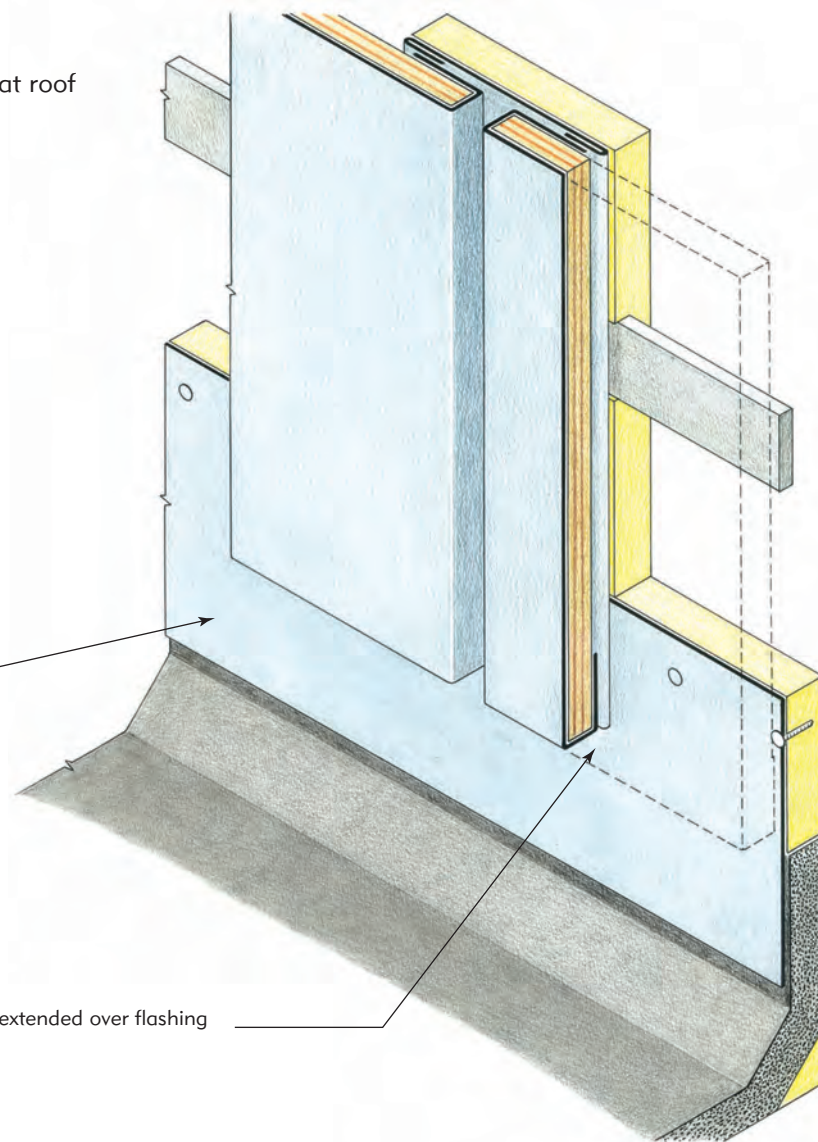
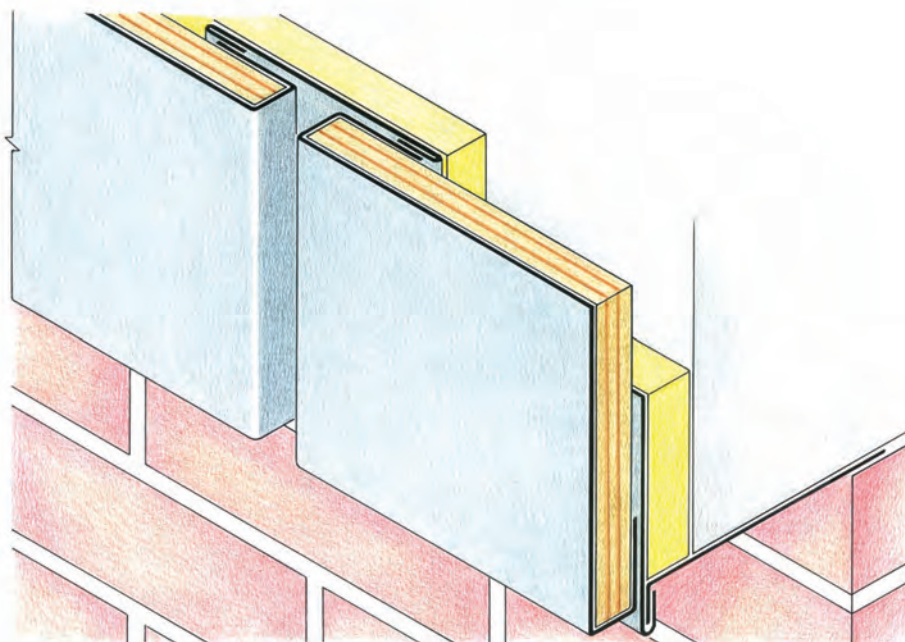
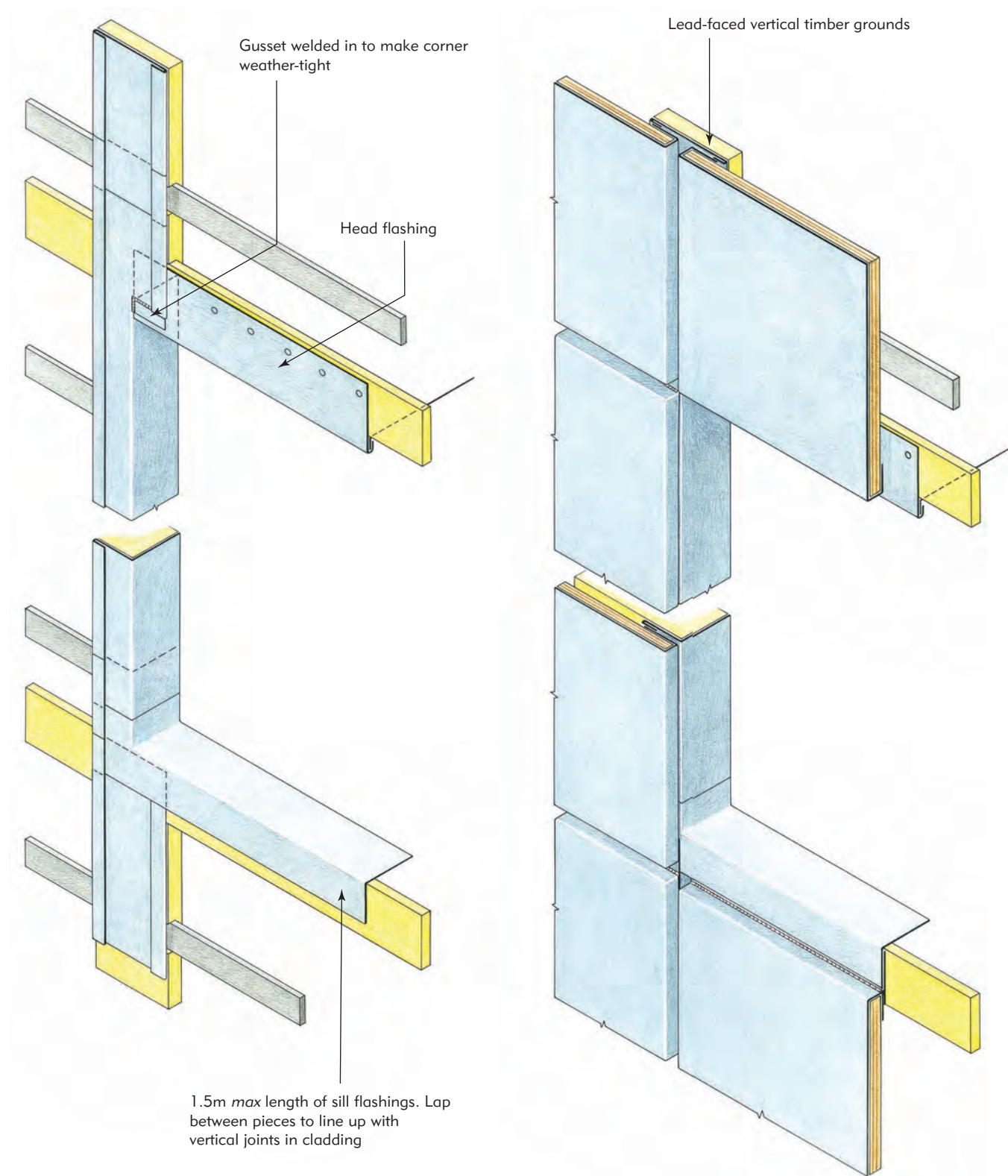


Fig 278. Finish over brickwork



Lead sheet cladding – preformed (cont.)

Fig 279. Windows and other openings



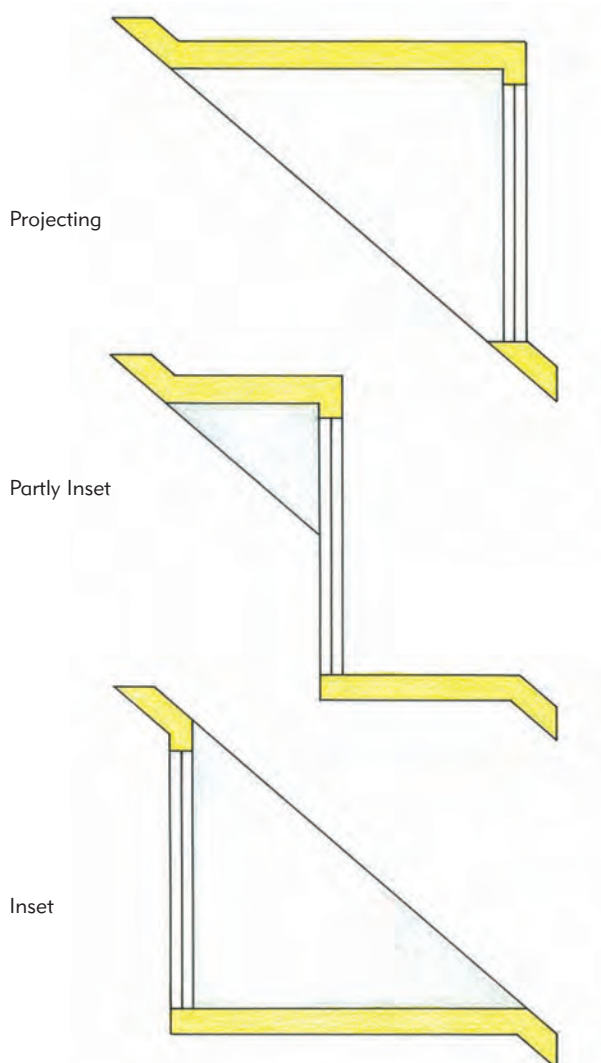
Dormer windows

Lead sheet is widely used to weather dormer windows – a common but distinctive feature of mansard and other pitched roofs. The design of dormer windows varies considerably. They may be wholly projecting from the roof, fully inset into the roof or, in some cases, partly projecting and partly inset (Fig 280). These differences in design obviously affect the detailing of the leadwork. Other factors that affect the method of weathering are the shape of the dormer top (that is, flat or curved) and whether the main roof is covered with lead, tiles or slates.

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

This section describes typical leadwork details that cover these main variations in dormer design. Modifications that may be required for specific cases can be based on these details.

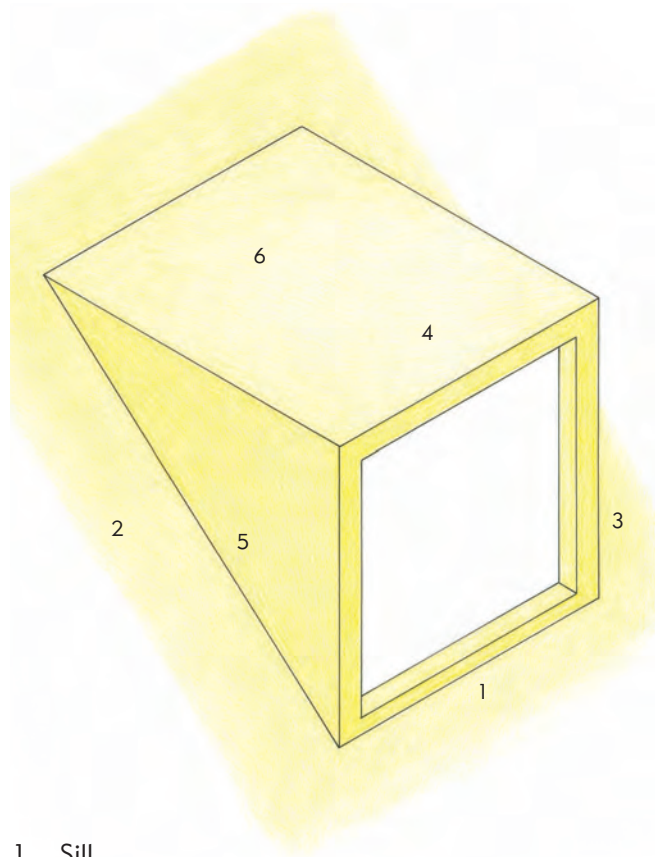
Fig 280. Types of dormer



Fully projecting dormers

The most common type of dormer is shown in Fig 281. Although there can be many variations in design, the leadwork involved in covering all dormers broadly comprises the weathering of the sill, jambs and in some cases the soffit, the cladding of the cheeks (including the junction with the roof covering) and the weathering of the dormer top.

Fig 281. Sequence of weathering



1. Sill
2. Junction with roof
3. Jambs
4. Soffit
5. Cheeks
6. Top



Dormer windows (cont.)

Sill

When constructing a dormer, it is essential for the top of the sill plate to be above the top of the roof covering. For both practical and aesthetic reasons, the front of the sill plate is normally fixed not less than 50mm above the roof (Fig 282). Sill weatherings can be formed by bossing, but it is usually easier and more practical to form the corners using lead-welded gussets (Fig 283). Two alternative gusset patterns are shown and both are correct, provided that the lead-welding is efficient. There is no set position for a gusset and where they are placed is normally the choice of the lead worker. However, it can be seen that the side flashing will cover the gusset on the left-hand side of the weathering. Therefore, in some cases this position may be preferred for aesthetic reasons.

At the sides, the cover over the slates or tiles should be not less than 150mm, but with deeply profiled tiles this may need to be increased to 200mm. The front apron should extend over the slates or tiles not less than 150mm, increasing to 200mm for very low-pitched roofs. Where the roof is covered with lead sheet, these allowances will depend on the position of the joint on each side of the dormer (Fig 301, page 187).

For large dormers, laps should be introduced in the sill weathering so that the overall length of each piece of lead does not exceed 1.5m. In the past, it was common to turn up the back edge of the weathering to prevent water penetration under the sill. With modern aluminium or plastic windows, this detail is usually omitted and a sealant is used to weather the joint between the window and the lead (see 'Sealants', page 11).

Fig 284 shows the sill weathering in position with the front and sides dressed to fit the tiles. Clips should be positioned along the front edge of the apron, spaced to suit the exposure of the building.

Fig 282. Sill height

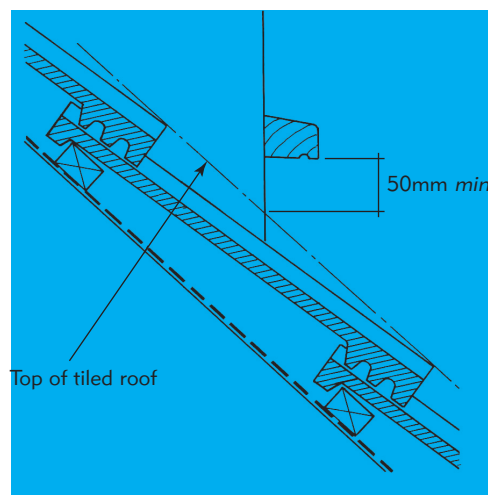
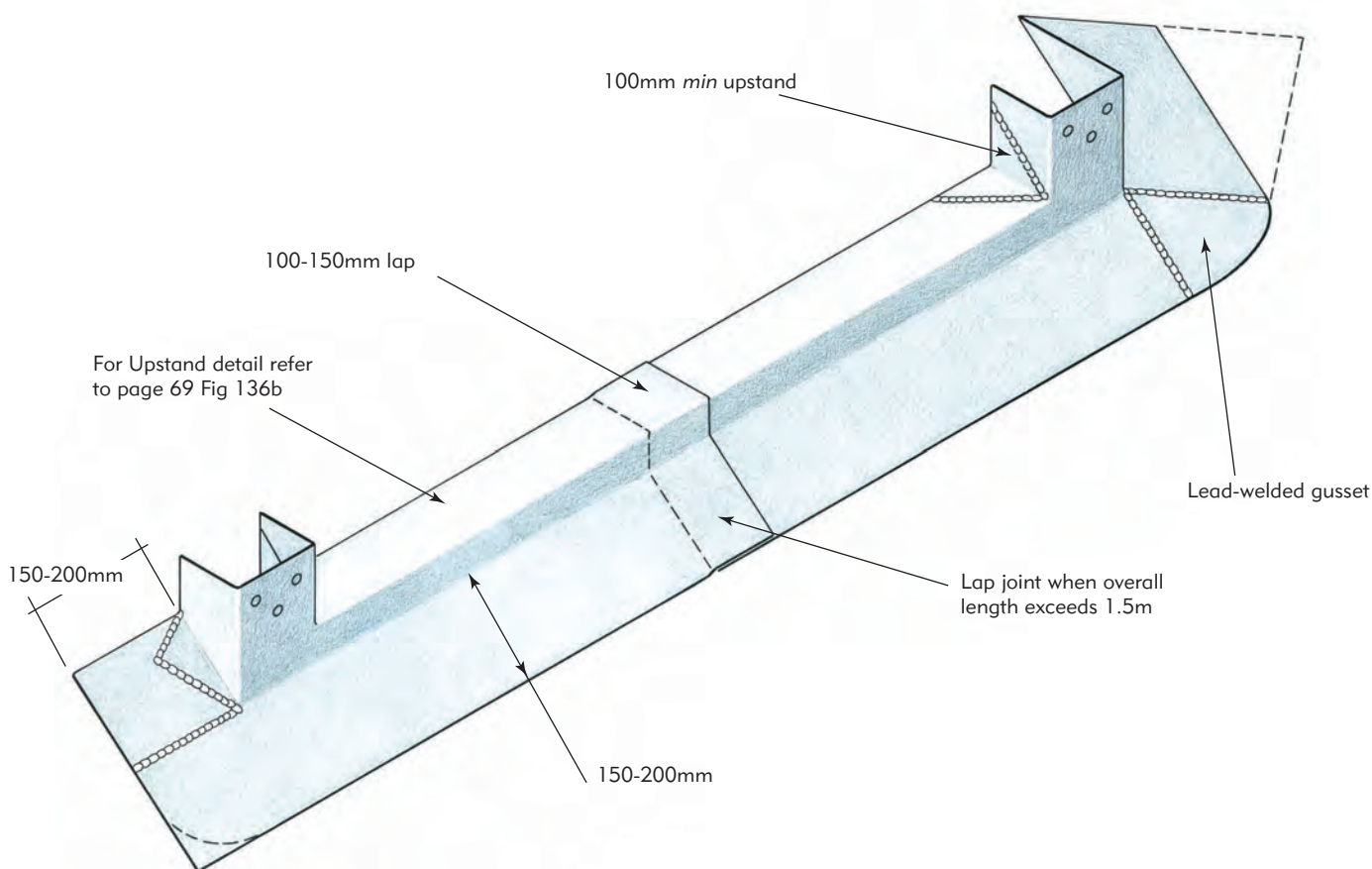


Fig 283. Sill weathering



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

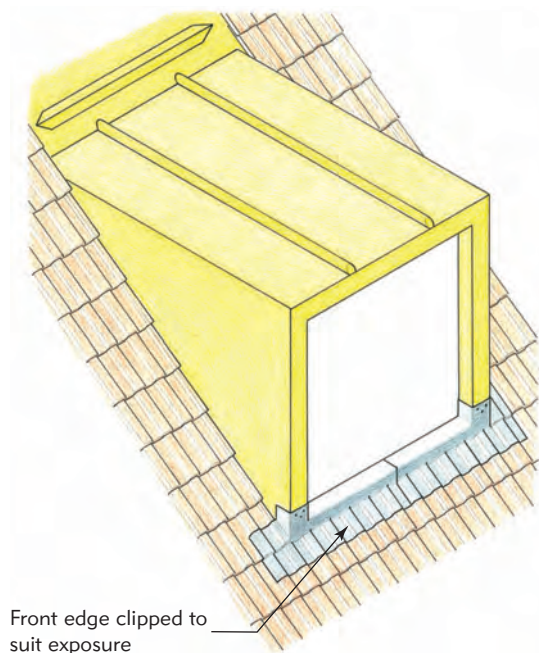
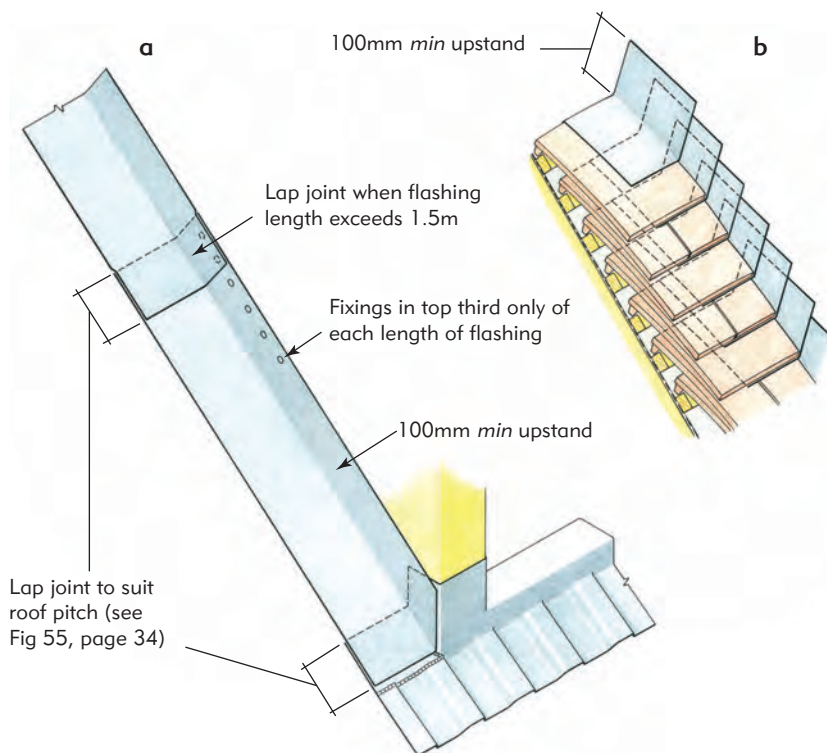


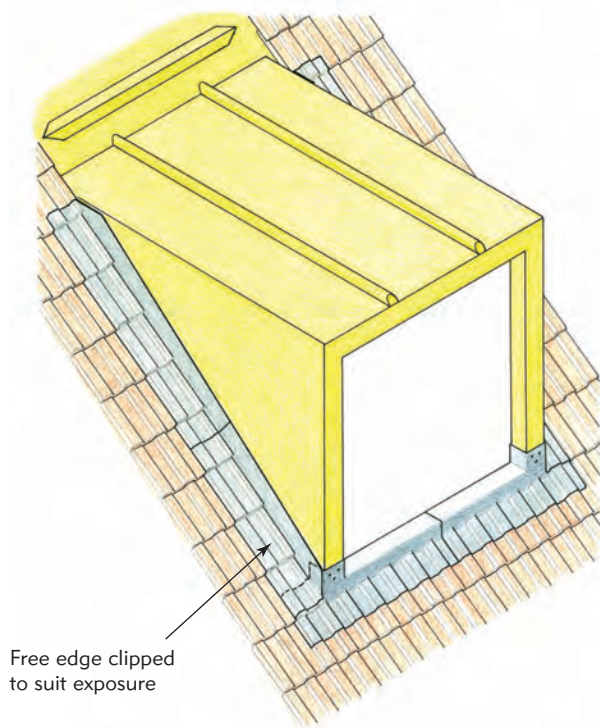
Fig 285. Side flashings



Dormer windows (cont.)

Fig 286 shows the side flashings in position. The 150-200mm extension is dressed to fit the contours of the tiles and the free edge is clipped to suit the exposure.

Fig 286. Side flashings in position



Jambs

Lead cladding to the jambs extends to the inside of the window frame, and 50mm is added to the width of the face to form the overlap when the jamb weatherings are subsequently welted to the dormer cheeks (Fig 287). The weatherings are held in position by nailing the top as shown. Where the overall length of the jamb exceeds 1.5m, laps must be introduced with a minimum cover of 75mm. In high-exposure situations, it may be necessary to increase the minimum cover to 100mm.

Soffit lining

Although optional, the soffit is sometimes lined with lead sheet, especially if the window frame is set back from the face of the dormer. Fig 288 shows the jamb weatherings and soffit linings in position. The soffit lining is nailed along the back edge at 150mm centres and the 25mm downstand at the front is clipped to the dormer face at 450mm-maximum centres, as shown.

Fig 287. Weathering to jamb and soffit

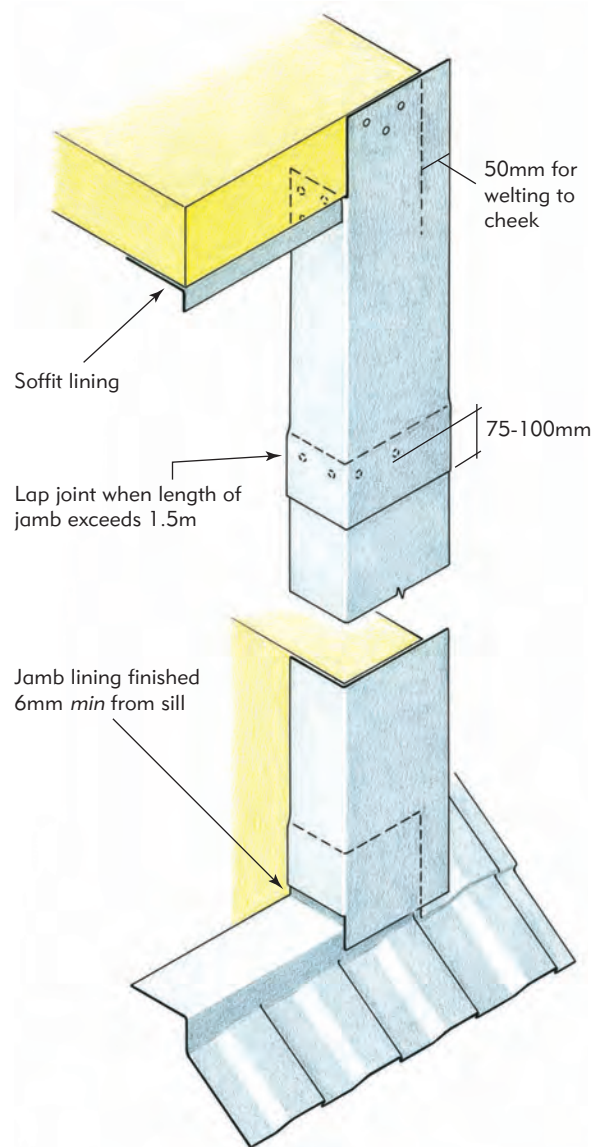
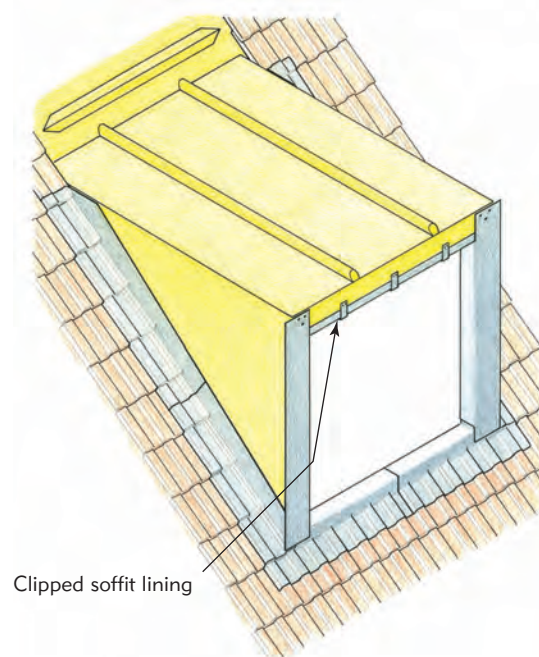


Fig 288. Jamb and soffit weatherings in position



Dormer windows (cont.)

Dormer cheeks

In cladding dormer cheeks, the sizing of panels and methods of fixing are basically the same as described in the section on wall cladding (pages 157-169). For codes 4 and 5 lead sheet, the thicknesses most commonly used for cladding dormer cheeks, these recommendations are summarised as follows.

In general, the spacing of vertical welted joints should not exceed 500mm when using code 4 or 600mm for code 5. The maximum height of a panel of lead is 1.5m for code 4 and 2m for code 5. Where the height exceeds these measurements, laps should be used for the horizontal expansion joints.

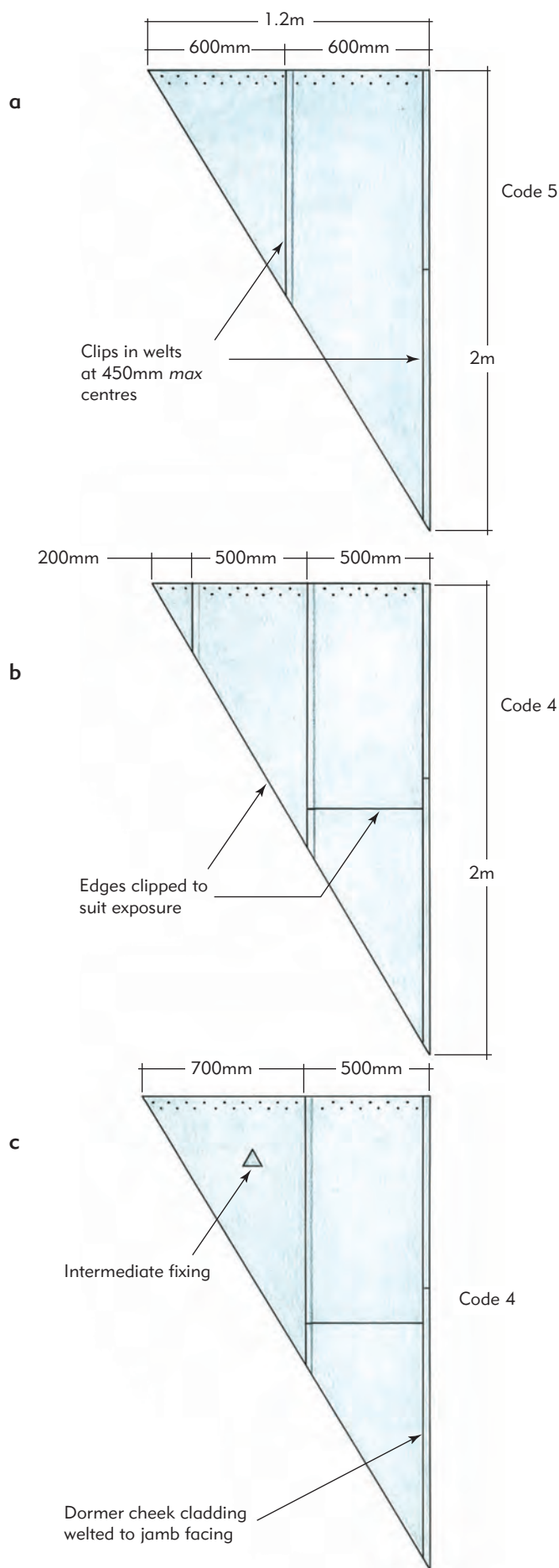
Fig 289a shows a dormer cheek clad with code 5 lead sheet. The 1.2m width divides conveniently into two 600mm-wide panels. With a height of 2m at the front edge, a lap joint is not required in the longest panel. The top of each panel is fixed with two rows of copper or stainless-steel nails at 75mm centres. Clips are positioned in the vertical welts and along the bottom edge to suit the exposure of the dormer. The bottom of the panels should lap over the side flashing or soakers by not less than 75mm.

To clad an identical cheek with code 4 lead sheet would require two vertical welts to keep within the recommended maximum spacing of 500mm for this thickness of material (Fig 289b). A horizontal lap joint would also be necessary in the longest panel to conform to the maximum height of 1.5m. Head fixings and the spacing of clips in welts and on free edges are similar to those used with code 5. If the height of a panel does not exceed about 500mm on its longest side, a single row of fixings spaced at 50mm centres will be adequate.

When the height of a panel of lead is less than the recommended maximum (1.5m for code 4), it is acceptable to increase the width of the panel and use an intermediate fixing. Fig 289c shows a similar cheek clad with code 4 but with the short welt replaced by an intermediate fixing (such as a capped screw fixing or soldered dot). The overall width of the wider pieces of lead must not exceed 800mm when using code 4 or 1m for code 5.

Although intermediate fixings are acceptable in these cases, their use generally is not recommended. Experience has shown that securing large pieces of dormer cheek cladding with numerous intermediate fixings results in fatigue cracking. Therefore, the tendency today is to position the welts so that intermediate fixings are not necessary.

Fig 289. Dormer cheeks

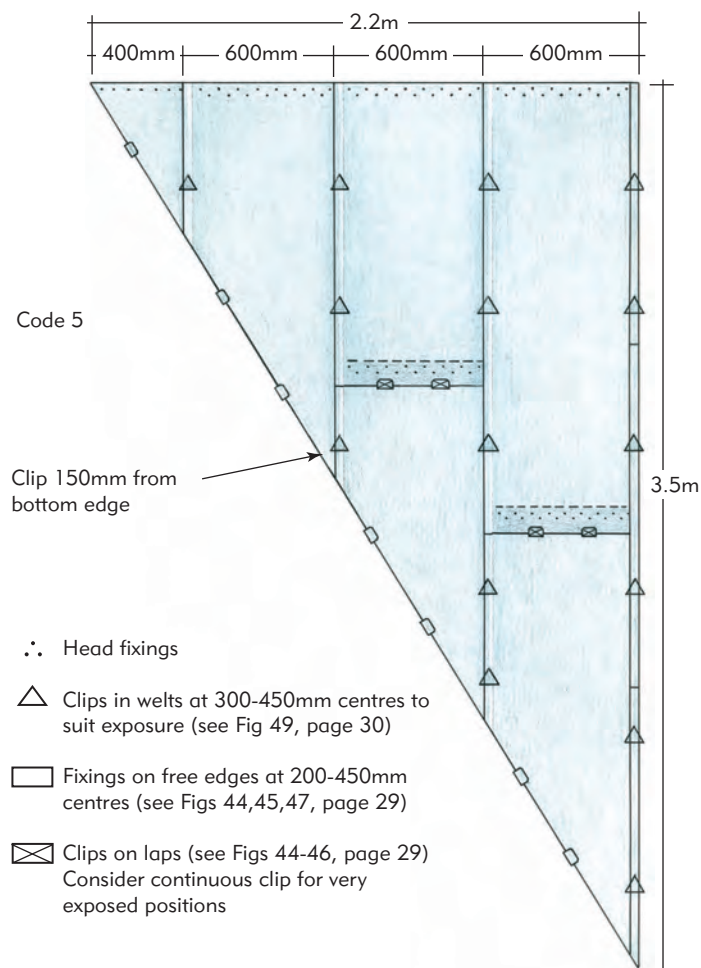


Dormer windows (cont.)

Fig 290 shows a large dormer cheek clad with code 5 lead sheet. The vertical welts are positioned at the maximum of 600mm for this thickness and the two panel heights that exceed 2m have been divided with horizontal lap joints. The position of the lap joints in this case can vary, provided that no piece of lead exceeds 2m in height.

Although the spacing of the vertical welts here is correct, there are two alternatives. The shortest welt could be omitted and an intermediate fixing positioned in the 1m-wide panel, as previously described. Alternatively, the welts could be spaced equally at 550mm centres. All three methods of cladding this dormer cheek would be correct and, as with most leadwork, provided that the recommended maximum sizes for each code of lead sheet are not exceeded, the exact layout is a matter of personal preference.

Fig 290. Large dormer cheeks



Figs 291a and b show the method of welting the jamb facing to the front edge of the dormer cheek. The fixing clips can be either fixed before the lead cheek is fitted, as shown, or fixed to the jamb facing after the cheek is positioned. After the cheeks are clad, as shown in Fig 292, the dormer is ready for the roof covering.

Fig 291. Welt at jamb/cheek corner

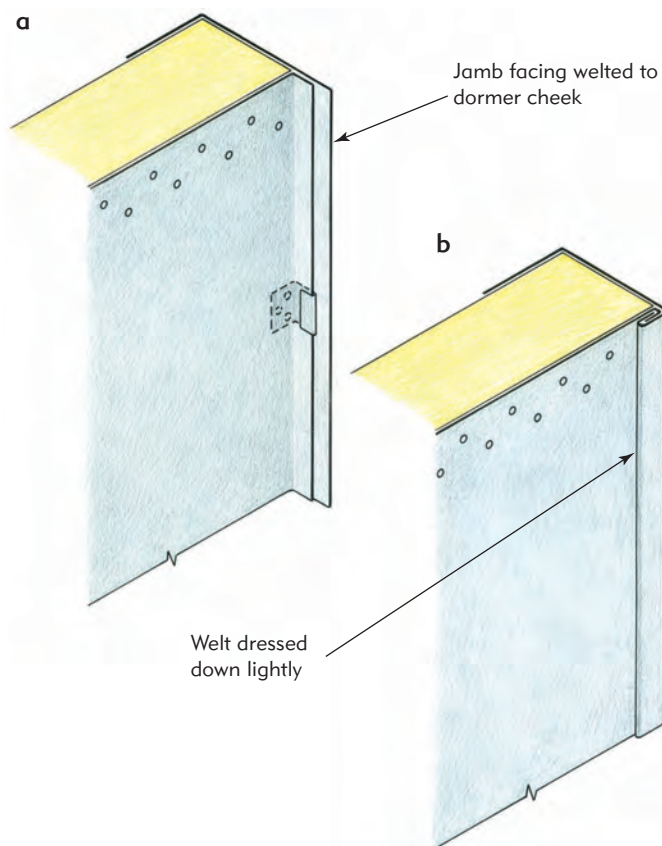
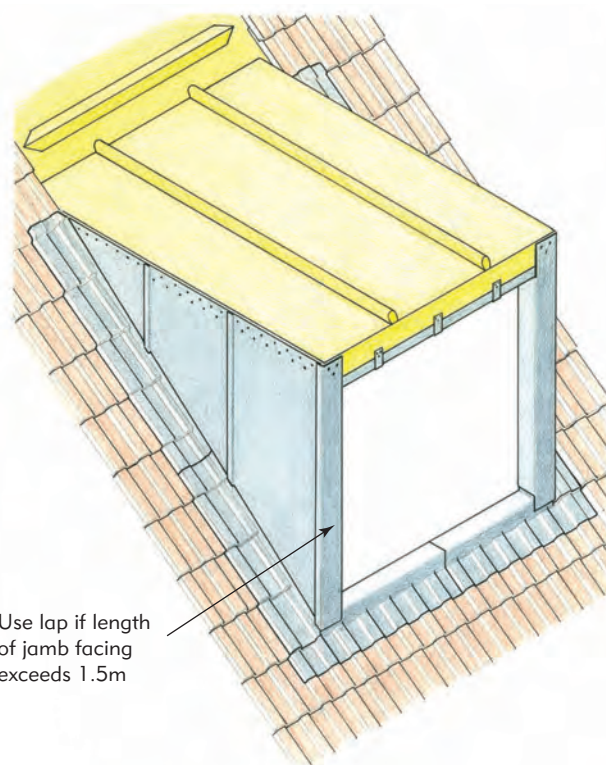


Fig 292. Dormer cheeks in position



Dormer windows (cont.)

Dormer tops

Fig 293 shows the detailing for a typical flat dormer top with the fall towards the front. The tilting fillet at the back is positioned about 150mm up from the surface of the dormer top, and the back edge of the lead is turned to form a single welt. At the sides, the lead is turned around clips spaced to suit the exposure of the dormer (Fig 294a), and then turned down to cover the cheeks by not less than 75mm (Fig 294b).

The fronts of the bays are turned down and the bottom edge then welted to the previously clipped downstand of the soffit lining. If a soffit lining is not fitted, the bottom edge of the lead must be independently clipped.

Fig 294. Clipping at sides

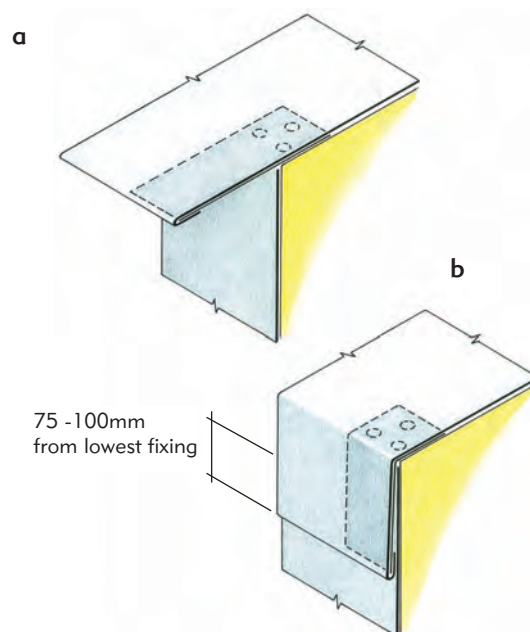
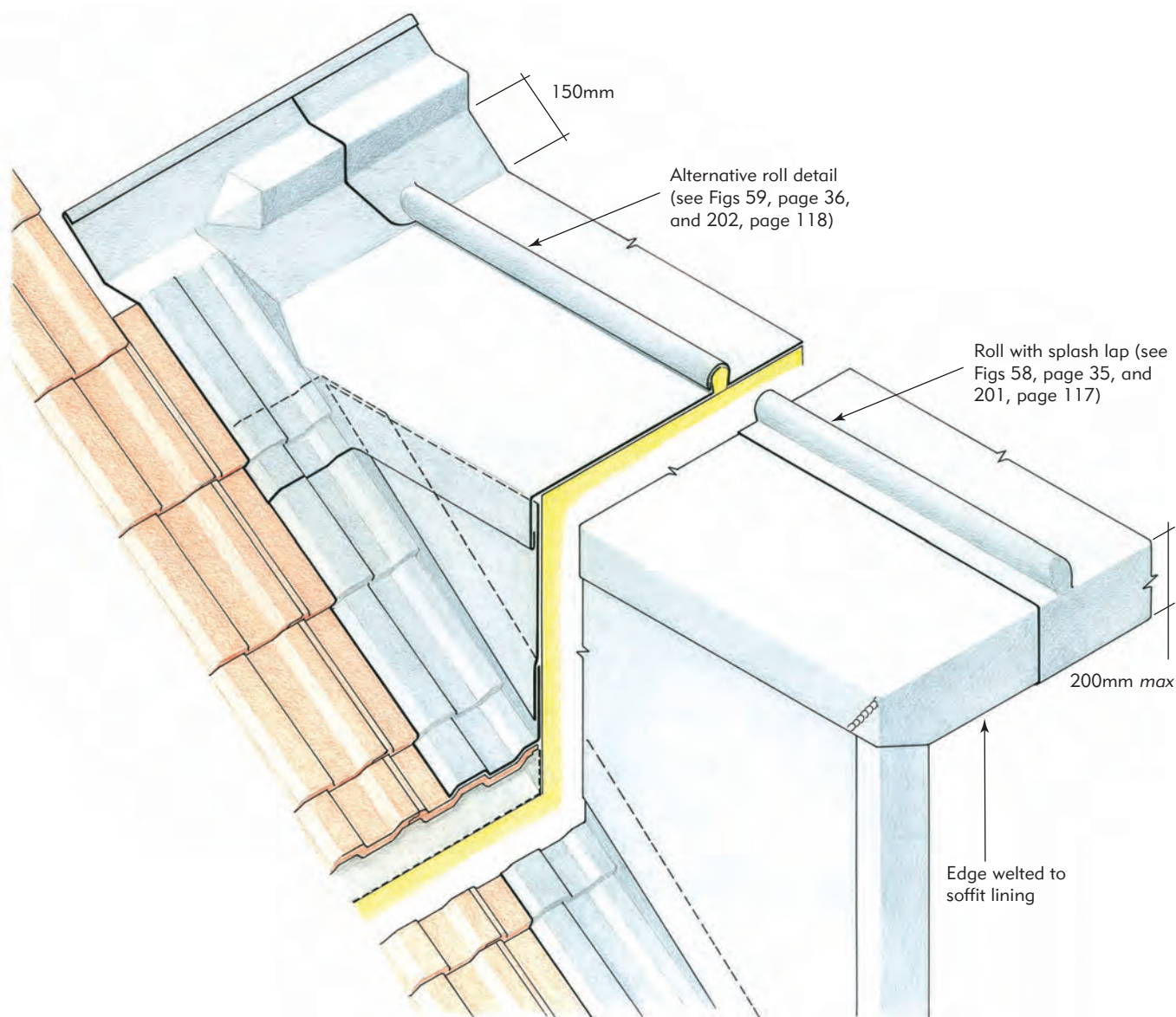
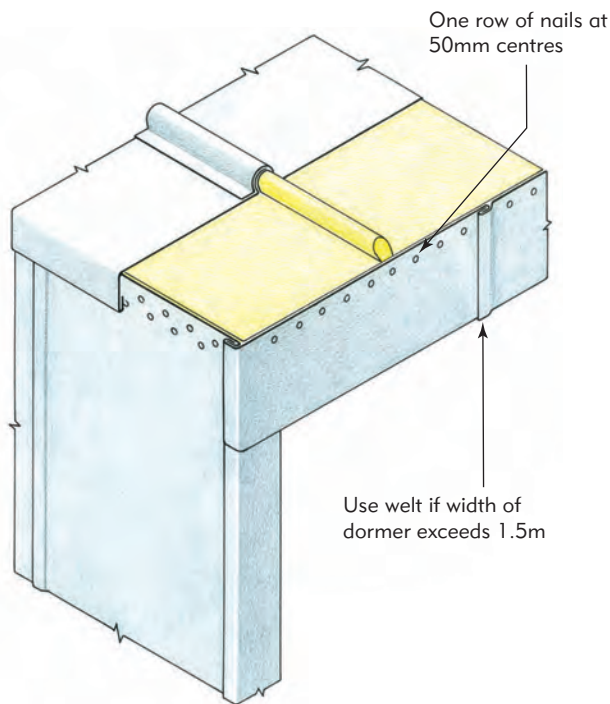


Fig 293. Dormer top – front and back corners



Dormer windows (cont.)

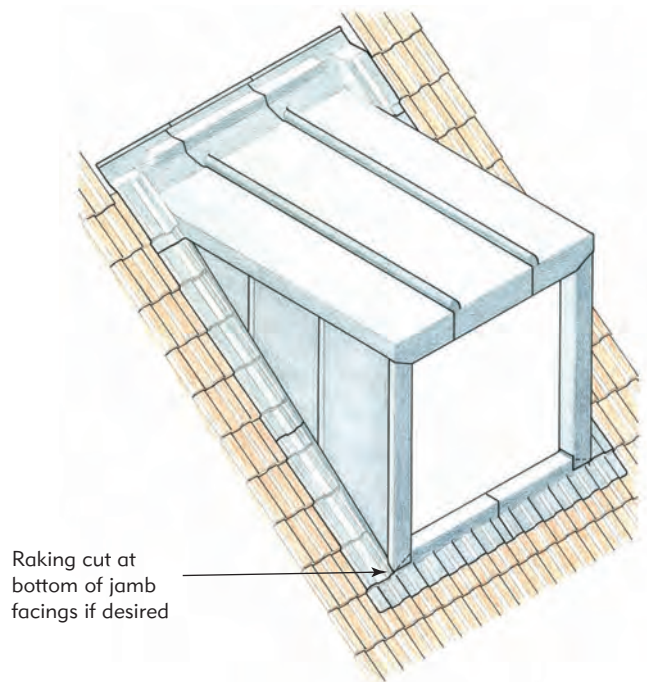
Fig 295. Deep fascia



Where the depth of the fascia exceeds 200mm, a separate piece of lead is used to weather the deep fascia (Fig 295), with welts introduced if the width of the dormer exceeds 1.5m. For fascias over 300mm deep, the welts are normally positioned centrally between the rolls.

Fig 296 shows the completed dormer window ready for the fitting of the window. The window is usually fixed almost flush with the jamb face, while the sill extends beyond the vertical upstand of the sill weathering.

Fig 296. Completed dormer



Joints between lead and window frame are normally sealed with plastic beads and/or sealants. The lead covering on this dormer is completely maintenance-free and if a plastic or anodised-aluminium window is used, no periodic painting is required. Since dormers are usually in positions where access for maintenance is difficult, the use of lead sheet for weathering dormers is particularly recommended.



Dormer windows (cont.)

Sizing and layout of dormer tops

The layout of the bays on a dormer will depend on the size of the top and whether the fall is to the back, front or sides. If the slope on a dormer with more than one roll were towards the back, rainwater would be retained in the centre section between the rolls. This would clearly be unacceptable.

Therefore, where dormer tops with more than one roll slope towards the main roof, a gutter should be provided between the dormer top and roof (Fig 297a). Alternatively, the rolls could be positioned as shown in Fig 297b. Fig 298 shows the maximum dimensions for single-piece dormer tops.

Fig 297. Dormer tops with fall to back or sides

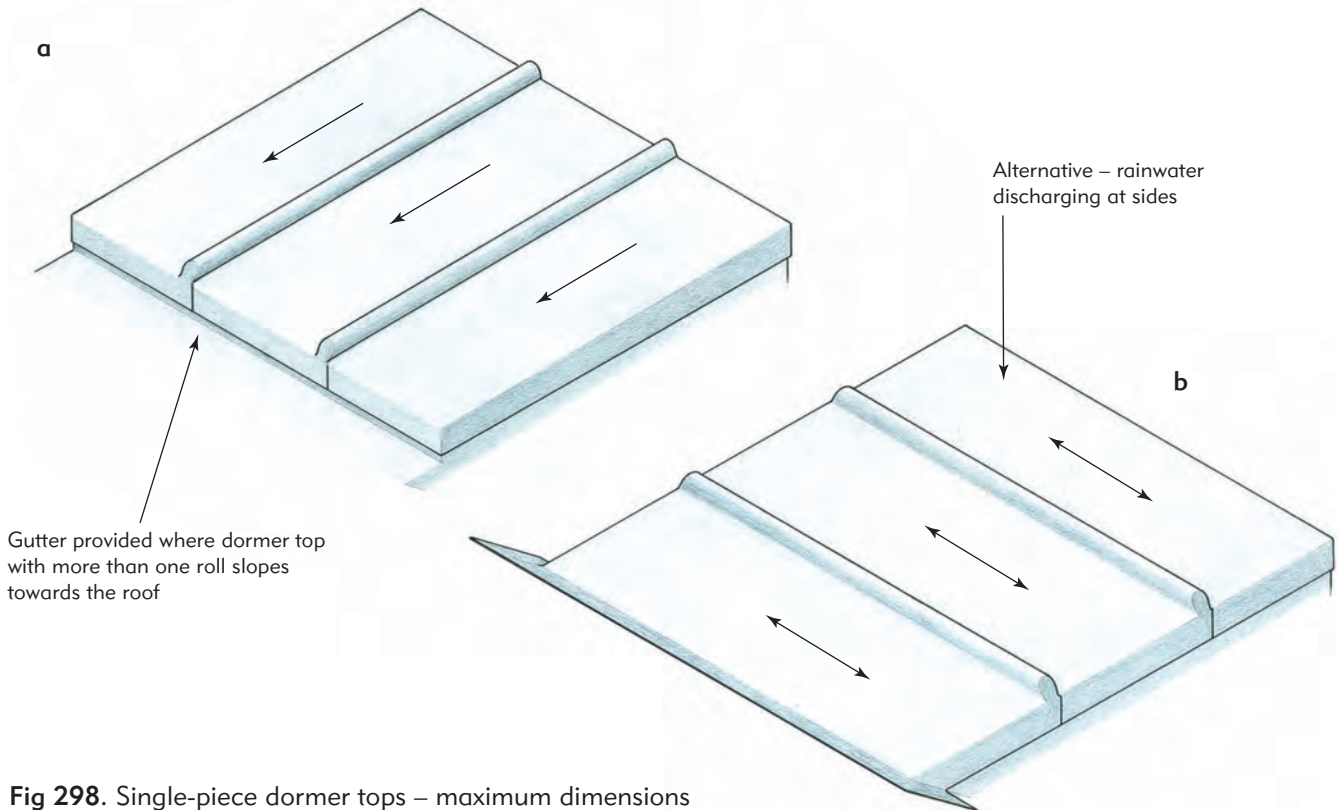
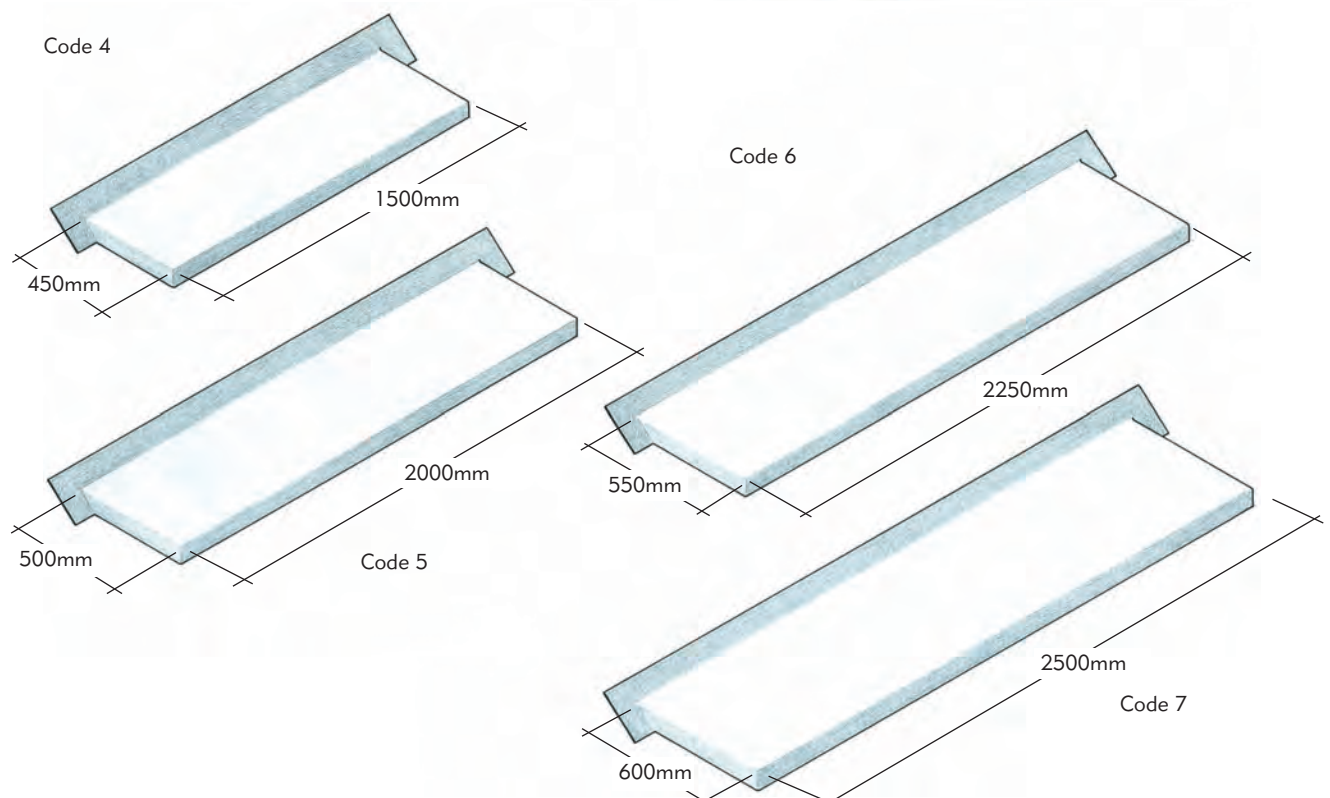


Fig 298. Single-piece dormer tops – maximum dimensions

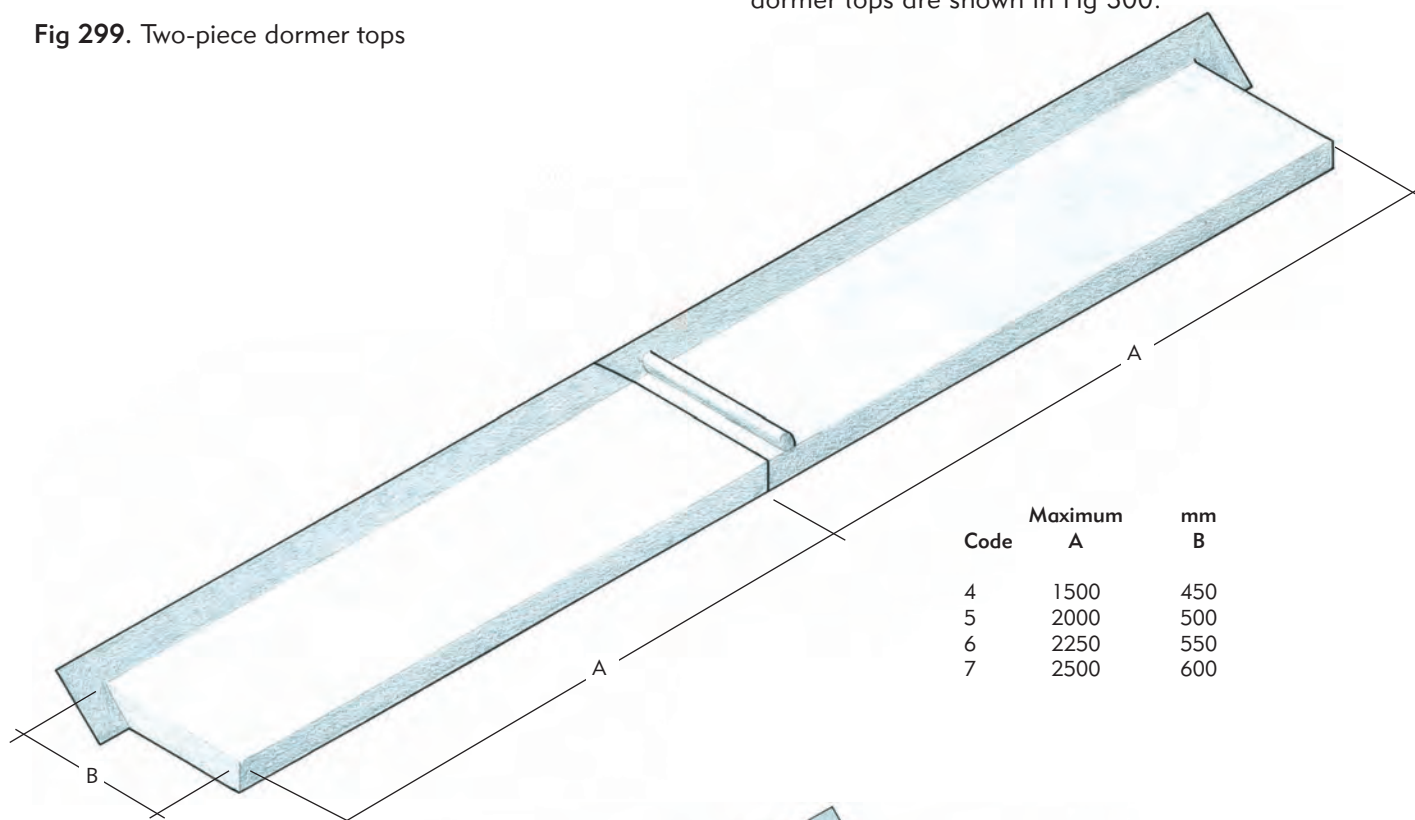


Dormer windows (cont.)

The sizes for two-piece tops are similar (Fig 299). For example, a 3m-long x 450mm top covered with code 4 lead sheet should have at least one roll. Note that welts are unsuitable for joining bays of lead on flat dormer tops.

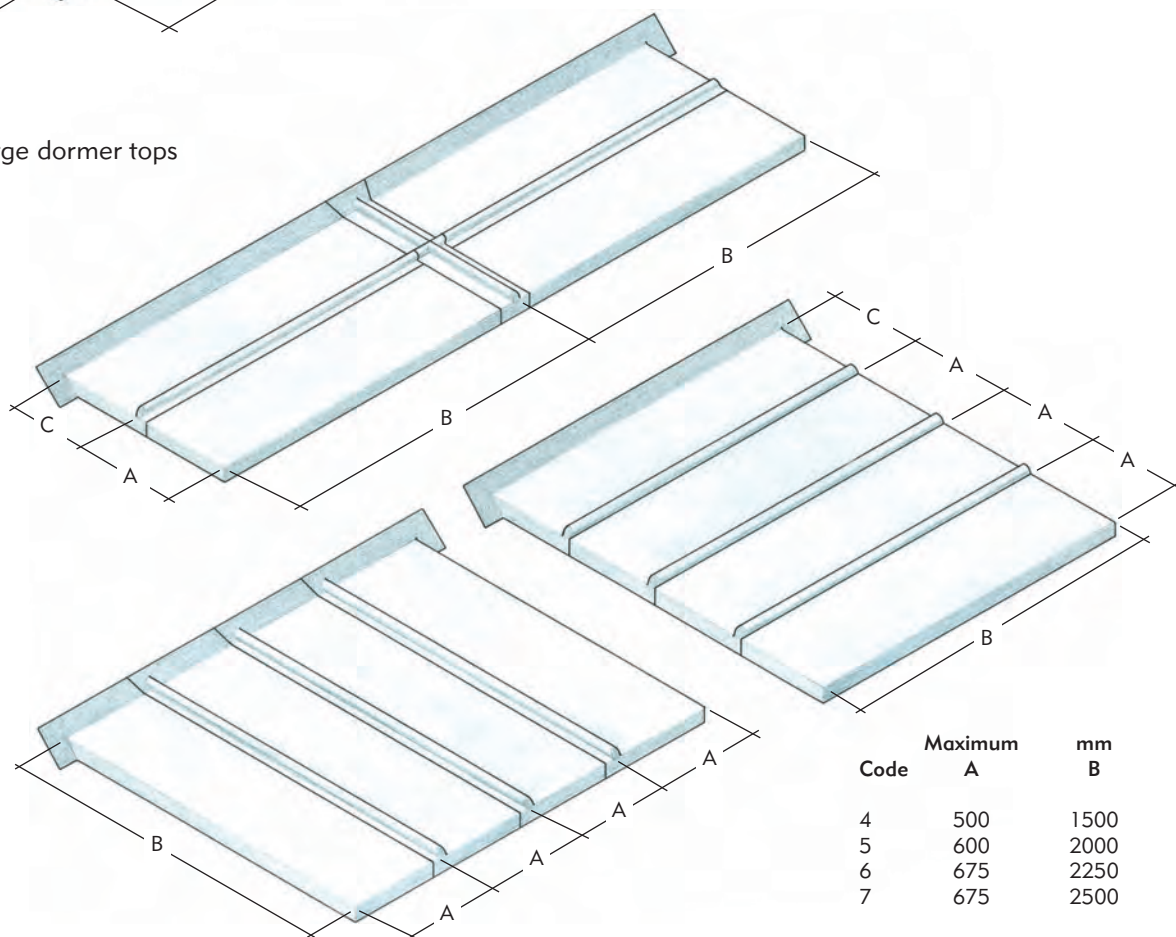
The widths shown can be varied, provided that the surface area of each bay is not exceeded. For example, code 4 would be suitable for a single-piece dormer top measuring 1.2m x 550mm. For code 5, a size of 1.7m x 600mm would give a similar area to the 2m x 500mm shown. Typical layouts for larger dormer tops are shown in Fig 300.

Fig 299. Two-piece dormer tops



Code	Maximum A	mm B
4	1500	450
5	2000	500
6	2250	550
7	2500	600

Fig 300. Large dormer tops



Code	Maximum A	mm B	C
4	500	1500	450
5	600	2000	500
6	675	2250	550
7	675	2500	600

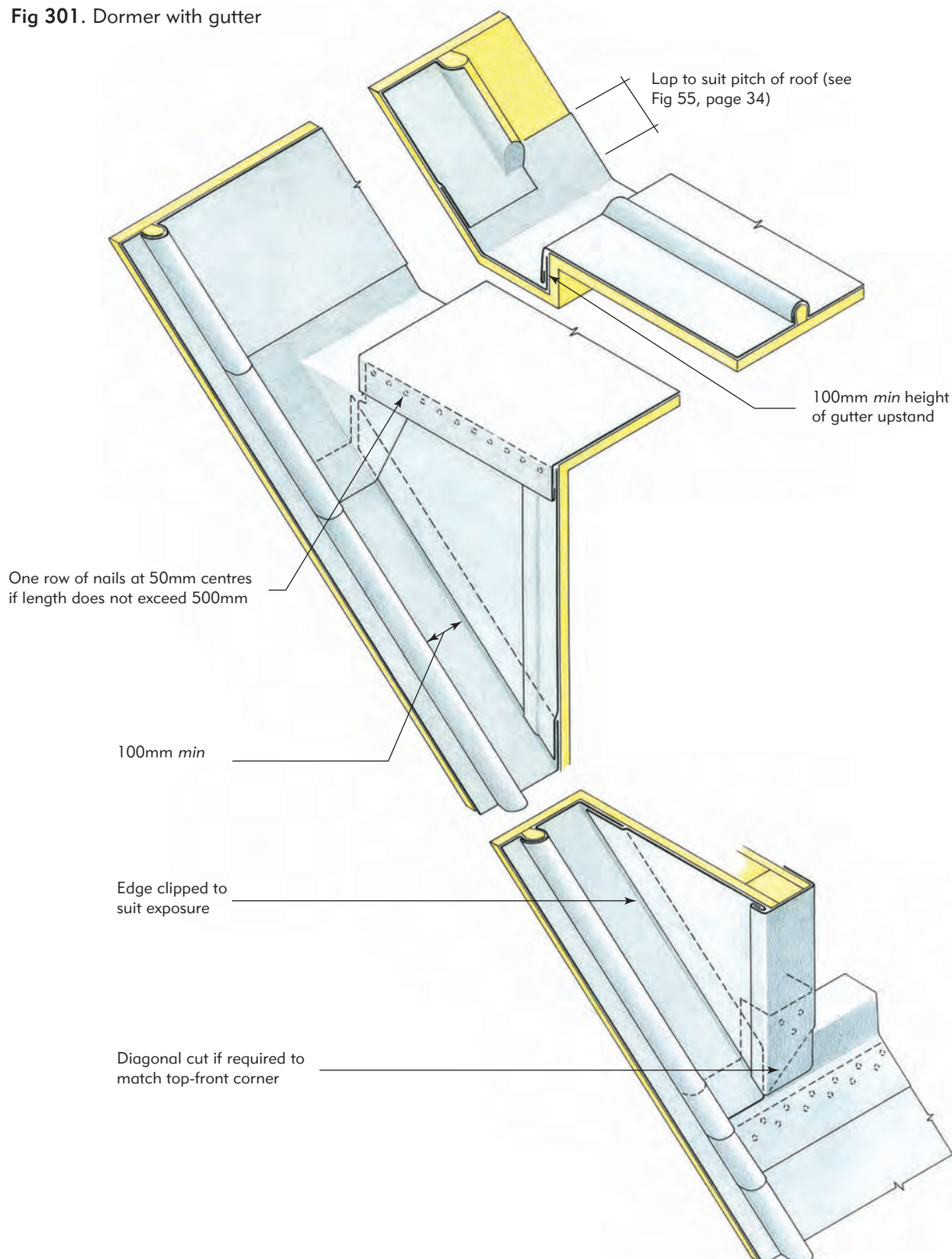
Dormer windows (cont.)

Dormers with back gutters

Occasionally dormers are designed with a gutter to collect the rainwater from the dormer top and the main roof. Fig 301 shows details of a dormer with a gutter where the main roof is covered with lead sheet.

It is essential that the gutter lining is not nailed at the sides as this will prevent free thermal movement and could result in premature failure. Whenever possible, the overcloak on the roll at each side of the dormer should be turned away from the cheek.

Fig 301. Dormer with gutter



Dormer windows (cont.)

Gutter lengths must not exceed the dimensions shown in Fig 302.

With a large dormer comprising several bays, the designer may wish to conceal the roll ends with a kerb so as to present a clean line at the head. Details of an example are shown in Fig 303.

Fig 302. Size of gutter linings

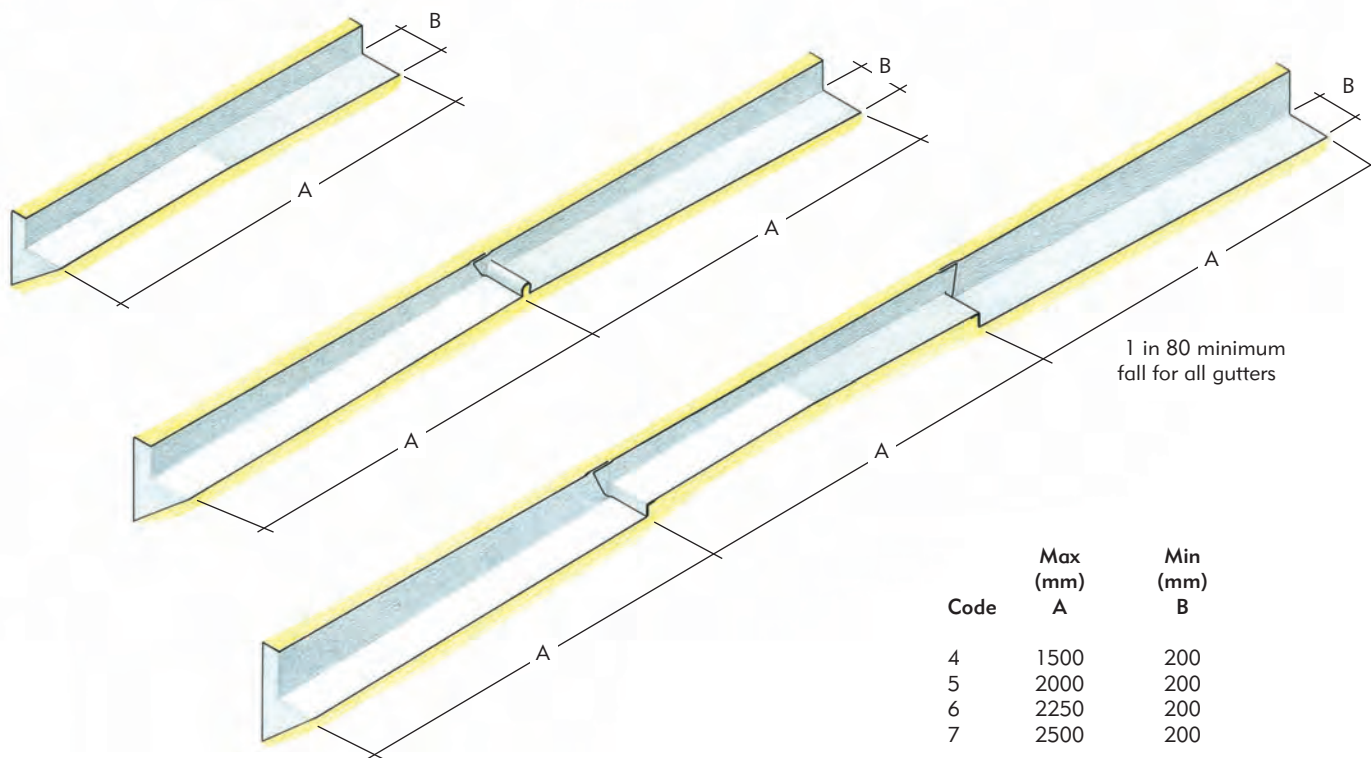
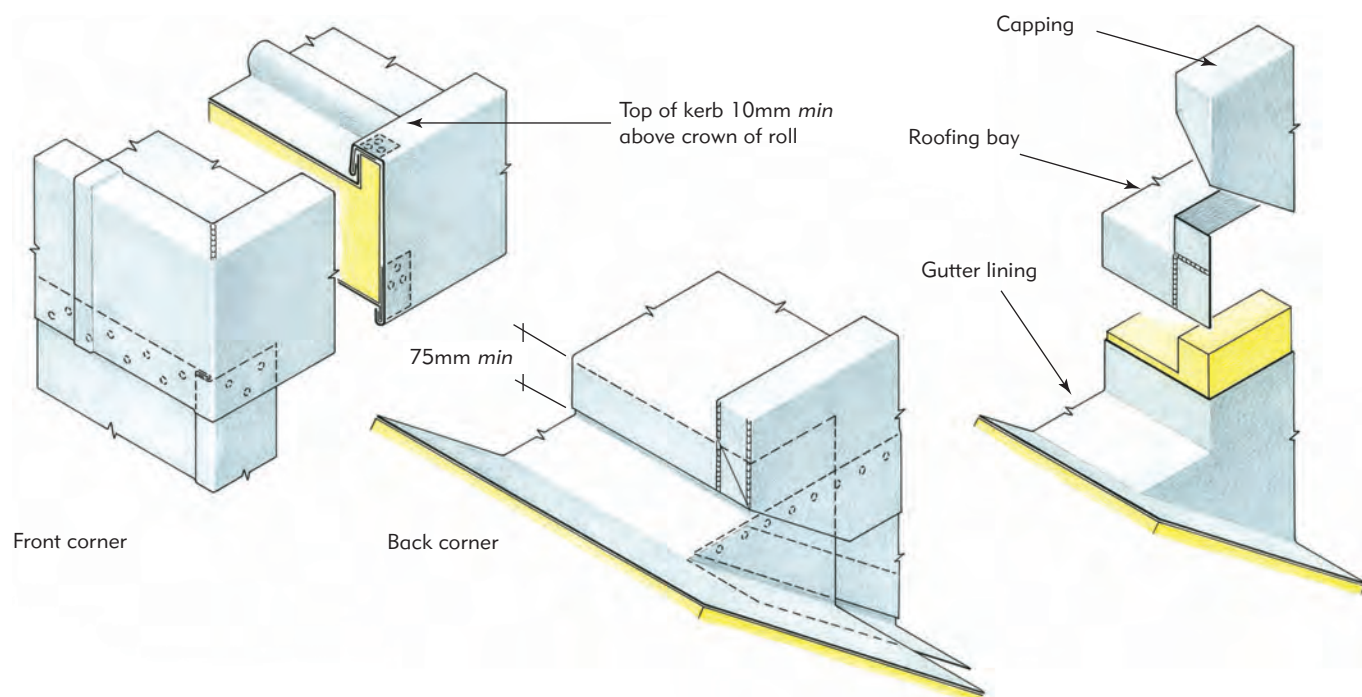


Fig 303. Dormer with kerb



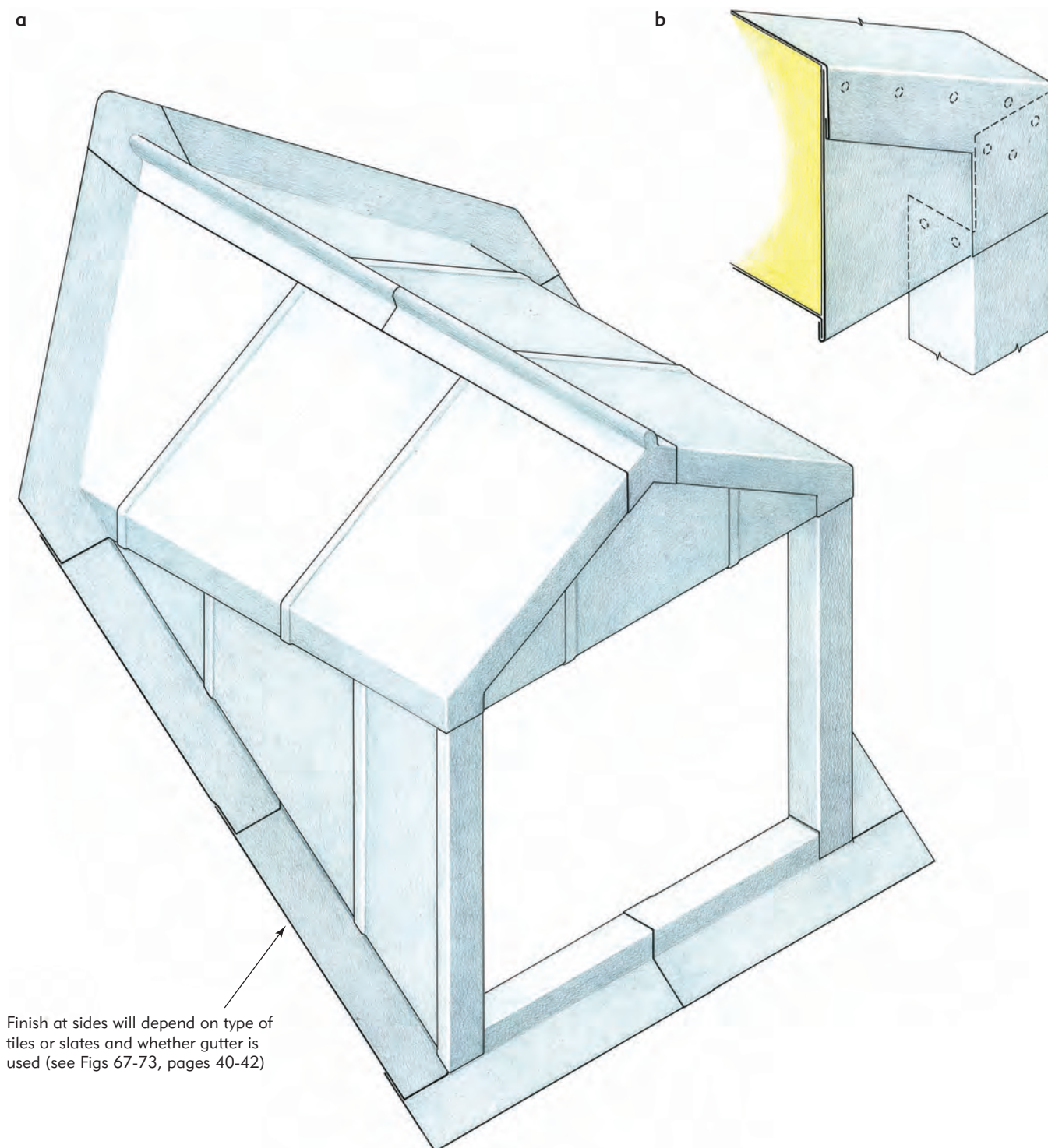
Dormer windows (cont.)

Pitched dormer tops

A typical example of a pitched dormer is shown in Fig 304a. Generally, welts are used to join the roofing bays, although rolls can be used where a bolder joint is required for aesthetic reasons. Rolls should also be used where the exposure and/or pitch of the dormer would make welts vulnerable to water penetration in storm conditions.

For the sake of appearances, the welts on the roof are sometimes designed to line up with those on the cheeks. However, this causes a considerable build-up of lead thicknesses where the welts lap each other, and therefore it is more practical to stagger the welts as shown. The cladding panels at the front lap over the jamb linings and the top is turned down to cover the nail fixings with the corner bossed or lead-welded (Fig 304b).

Fig 304. Pitched dormer top



Dormer windows (cont.)

When the length of lead on each side is not more than 1m, the welts can be carried over the apex (Fig 305).

For longer lengths, a roll is positioned along the ridge and the top of each bay is fixed as shown in Fig 306. 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 (see page 152). For aesthetic reasons, the extension on each side is often longer and, depending on the length of cover and pitch of dormer top, it may not be necessary to seal the nail heads.

Fig 305. Welts carried over ridge

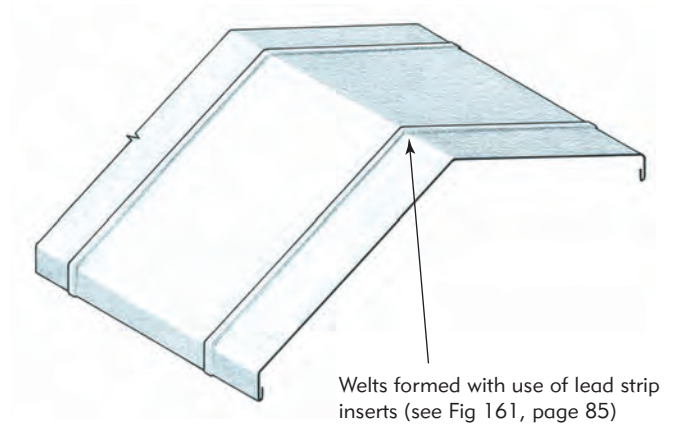
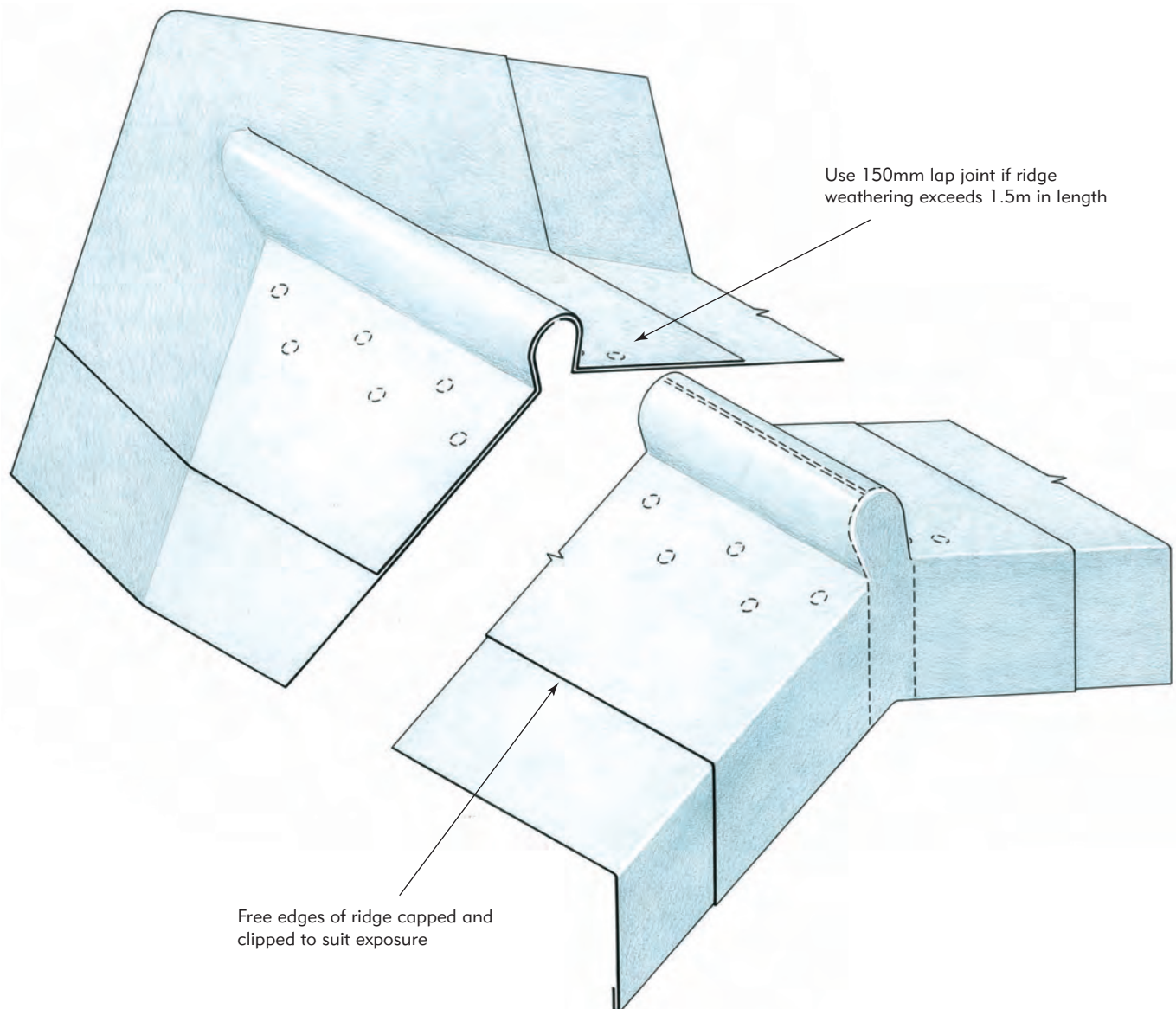


Fig 306. Ridge details



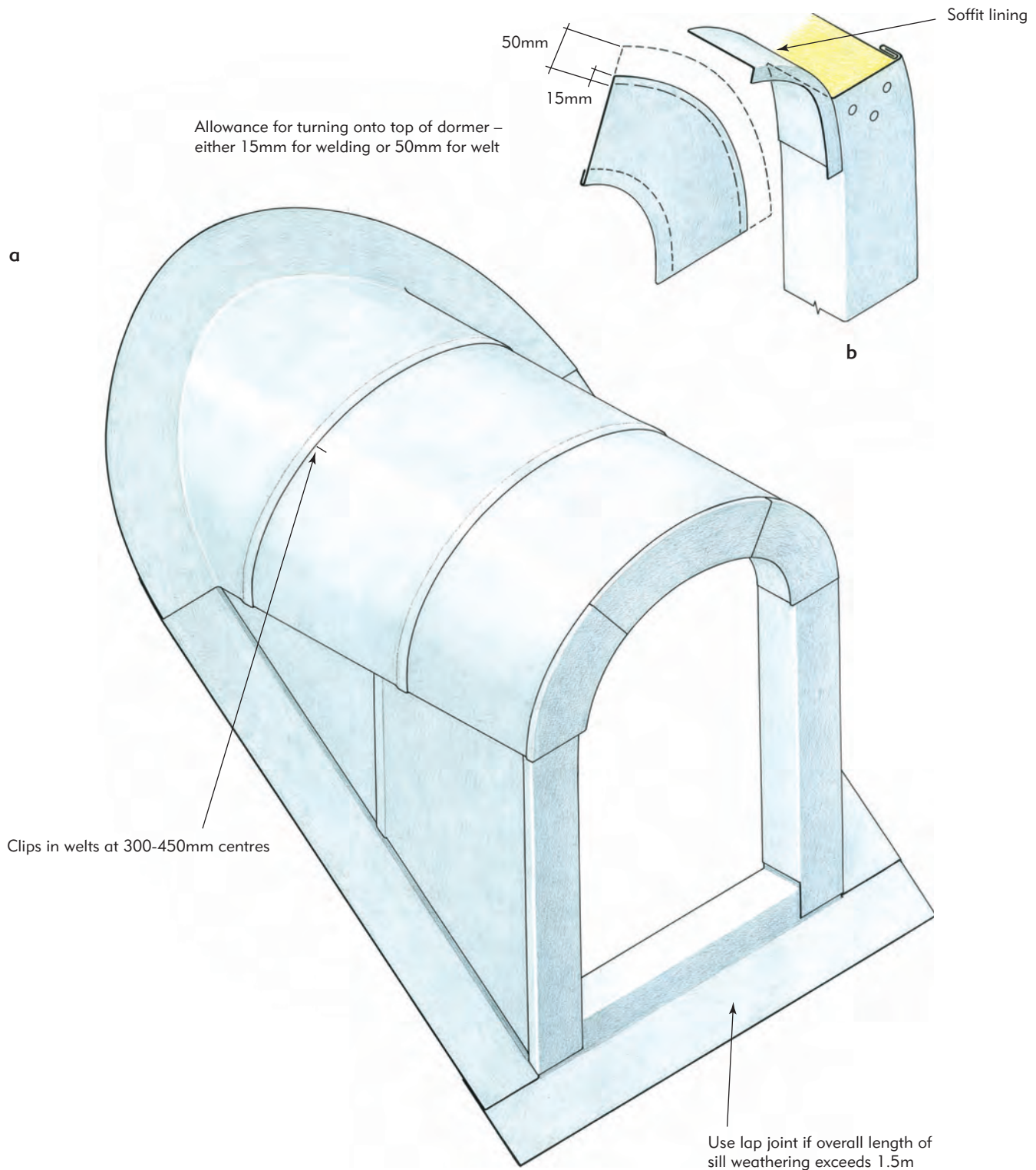
Dormer windows (cont.)

Curved and barrel-vaulted dormer tops

An example of a small curved dormer is shown in Fig 307a. As with pitched dormer tops, welts are often used to join the bays, but rolls can be used if required. Although it is possible to boss down the front bay of lead to weather the curved face of the dormer, it is seldom acceptable for aesthetic reasons.

Therefore, separate pieces of lead are more generally used with lap joints (Fig 307b). The top edge of these pieces can either be welted to the roofing bay or turned down about 15mm onto the top of the curved roof and lead-welded to the front bay.

Fig 307. Curved dormer top



Dormer windows (cont.)

The method of weathering at the back and sides will depend on the material used to cover the main roof. A method that is often used, particularly with slates or double-lap plain tiles, is to form a gutter around the dormer (Fig 308). For a lead-covered roof, the junction at the back corner is shown in Fig 309. The detail for the sill corner will be the same as Fig 301 (page 187).

With large curved or barrel-vaulted dormer tops, the detailing (shown previously) is similar for the sill, sides, jambs, soffit and cheeks. However, it is important that the lengths of the individual pieces of lead for each application are limited to the recommendations already stated (for example, 1.5m-maximum length for sill weatherings).

Fig 308. Details for tiled or slated roof

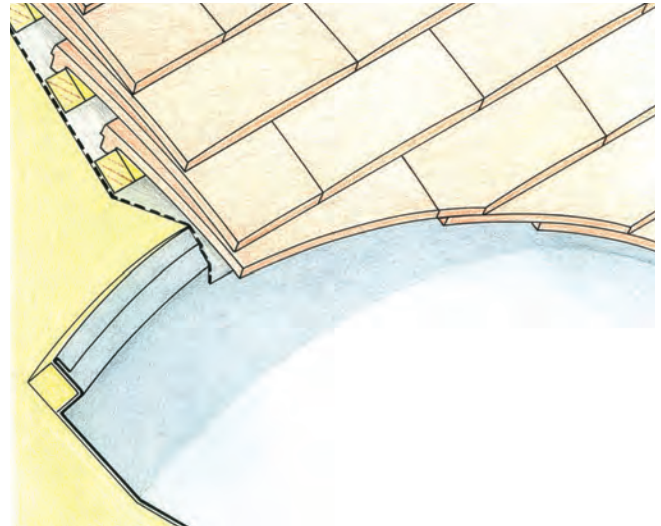
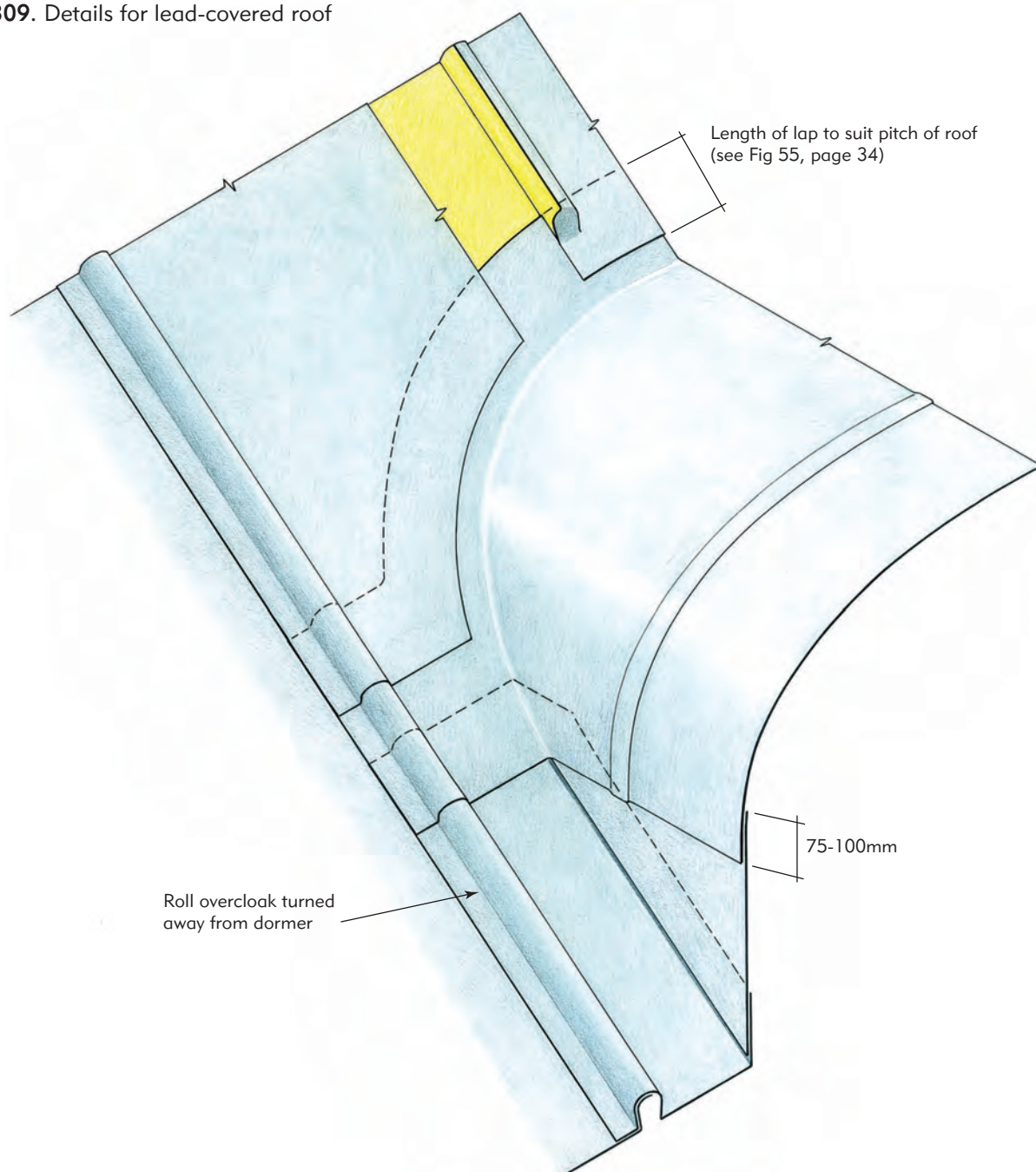


Fig 309. Details for lead-covered roof



Dormer windows (cont.)

Large barrel-vaulted dormer tops

The layout of the panels of lead on the top will depend primarily on the exposure of the dormer and the quality of the building. This will determine the thickness of lead to specify, the type of joint to use and the spacing of clips in the joints and along free edges. For most large dormers, code 5 is the minimum thickness of lead to use with welts or rolls spaced at 600mm-maximum centres.

Welts are normally acceptable for joints with the fall, although rolls may be preferred in some cases for their bold appearance. In severe exposures, however, rolls must be used because the near flat area at the top would make welts vulnerable to water penetration in high winds and heavy rainfall.

Although not essential, it is normal practice for the top panel of lead to extend on each side of the apex rather than using a ridge roll. This avoids the fixing and weathering of the ridge roll and the fixing and sealing of the nails that would be required at the top of each panel of lead. It is important that the length of lap on each side conforms to the lap requirements of Fig 55,

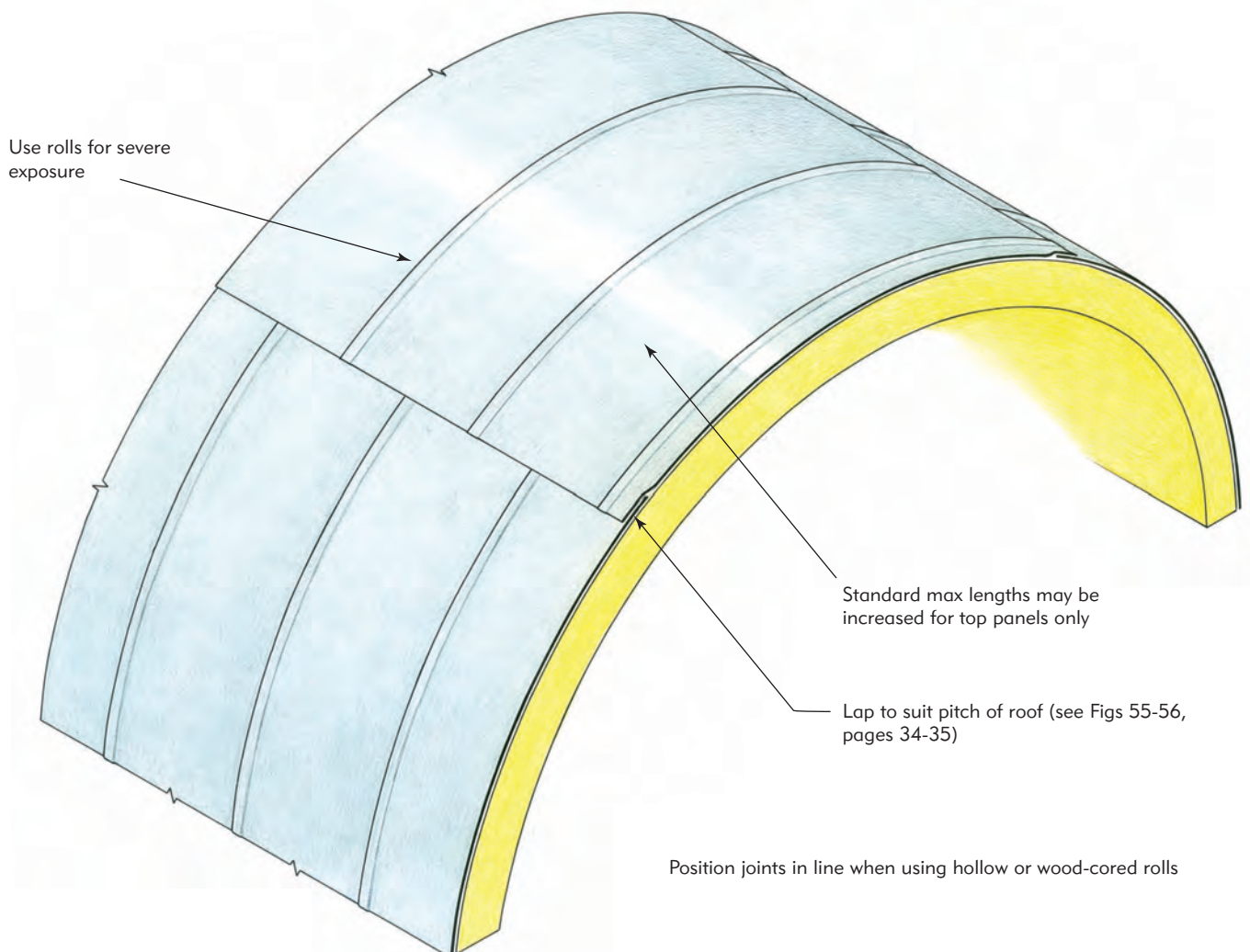
page 34. (Note: the closer the laps are positioned to the centre point of the top, the shallower the pitch of the roof becomes and the greater the lap will need to be.)

Fig 310 shows a layout with staggered welts but, if desired, the welts can be in line. When using wood-cored or hollow rolls, the joints are always detailed in line.

For most leadwork, the maximum length of bays or panels must not exceed the recommendations in Tables 12 and 13 (page 141) – for example, 2m for code 5. However, thermal expansion and contraction within these top panels can take place at the lap joint on each side, so the pieces of lead can expand in both directions.

For the side panels, which are nailed at the top, the movement can take place only in one direction. For the top curved panels, therefore, it is permissible to increase the normal recommended maximum length to 2.5m for code 5, 2.8m for code 6 and 3m for code 7. This is sometimes necessary on very large curved or barrel-vaulted roofs to achieve a position on each side where the pitch is suitable for a lap joint.

Fig 310. Barrel-vaulted top



Dormer windows (cont.)

Inset dormers

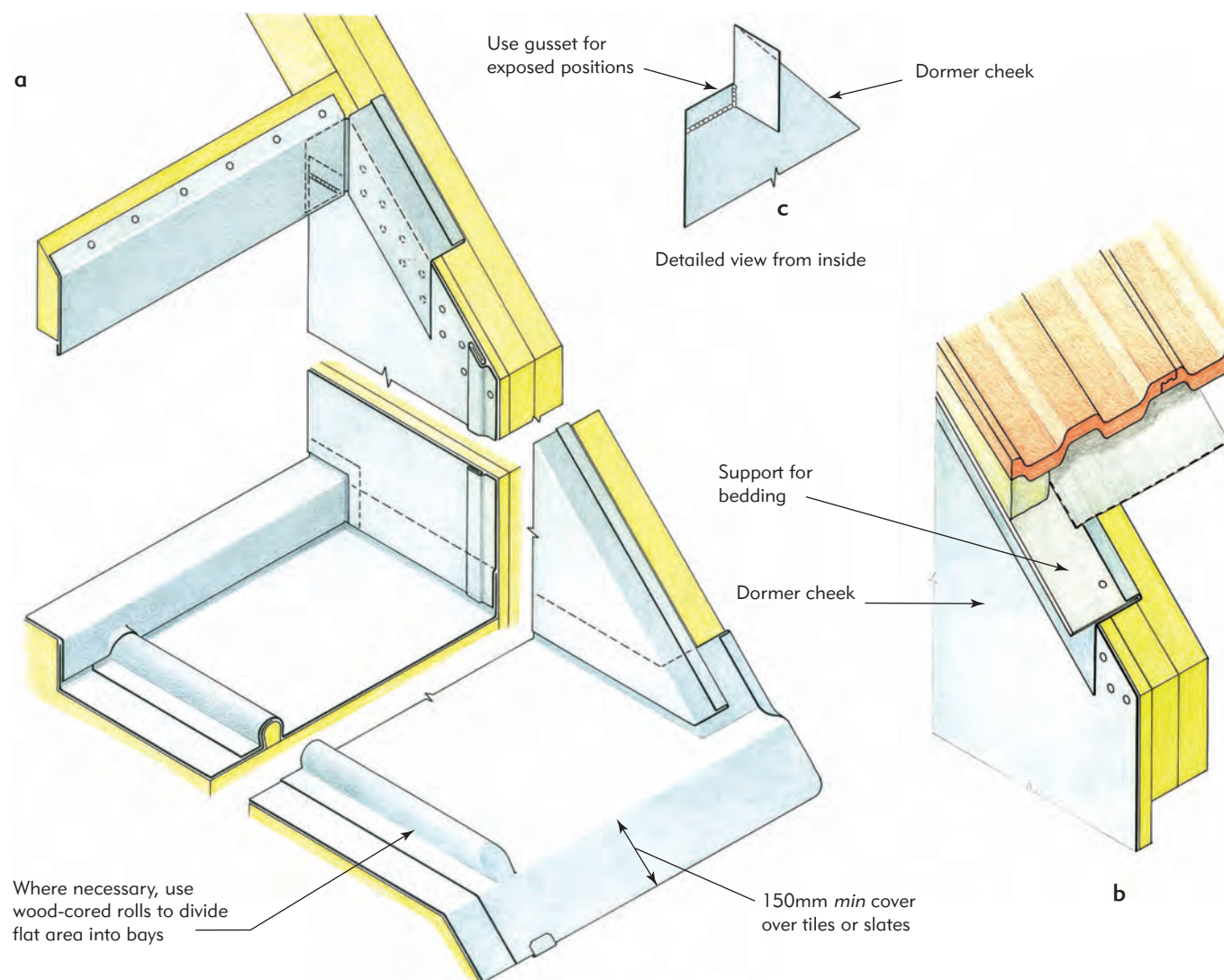
Typical leadwork details for a fully inset dormer window in a slated or tiled roof are shown in Fig 311a. For large dormer cheeks, the top of each panel is fixed with two rows of copper or stainless-steel nails. A separate piece of lead is welded around the support material for the verge bedding and turned to cover these lead fixings (Fig 311b). With small single-piece dormer cheeks, the separate piece of lead can be omitted. The top of the cheek is turned over and nailed at 50mm centres with the back edge welted around the verge support material (such as slate).

Although the top corners of the cheeks will be covered with tiles or slates, and in some cases an eaves gutter may also be fitted, it will be necessary to weld in a gusset if rainwater can be driven into these corners in storm conditions (Fig 311c).

The previous notes on sizes of panels for the cheeks of projecting dormers will also apply to the cheeks of inset dormers. However, with inset dormers the sides of the longest panels are firmly fixed by the window jambs. Therefore, in sunny exposures, it is important that each piece of lead in these positions is limited to a length of 1m for code 4 or 1.5m for code 5.

The method of covering the flat area at the bottom of an inset dormer will depend on its size and the thickness of lead sheet used for the work. Where necessary, wood-cored rolls should be used to divide the area into bays not exceeding the recommended maximum sizes for flat roof coverings.

Fig 311. Inset dormer



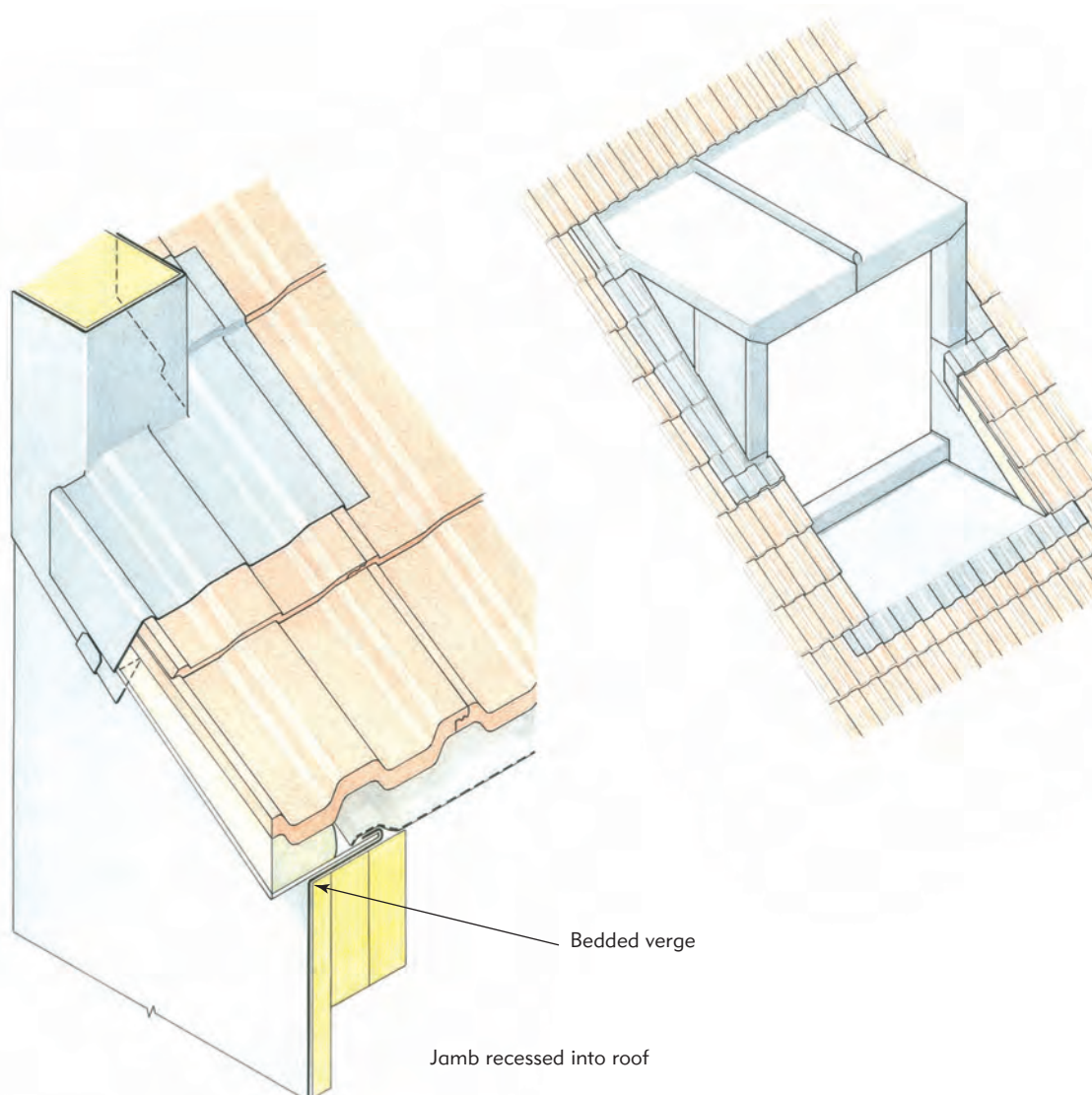
Dormer windows (cont.)

Partly inset dormers

Leadwork to partly inset dormer windows will comprise a combination of the various details shown for fully projecting and inset dormers. The weathering required where the dormer changes from projecting to inset will depend on the position of the jambs and the method of forming the verge – that is, dry verge, bedded verge or cloaked verge. Figs 312 and 313 show two examples. In both cases, the lead weathering at the intersection will be best formed by cutting and lead-welding on the bench.

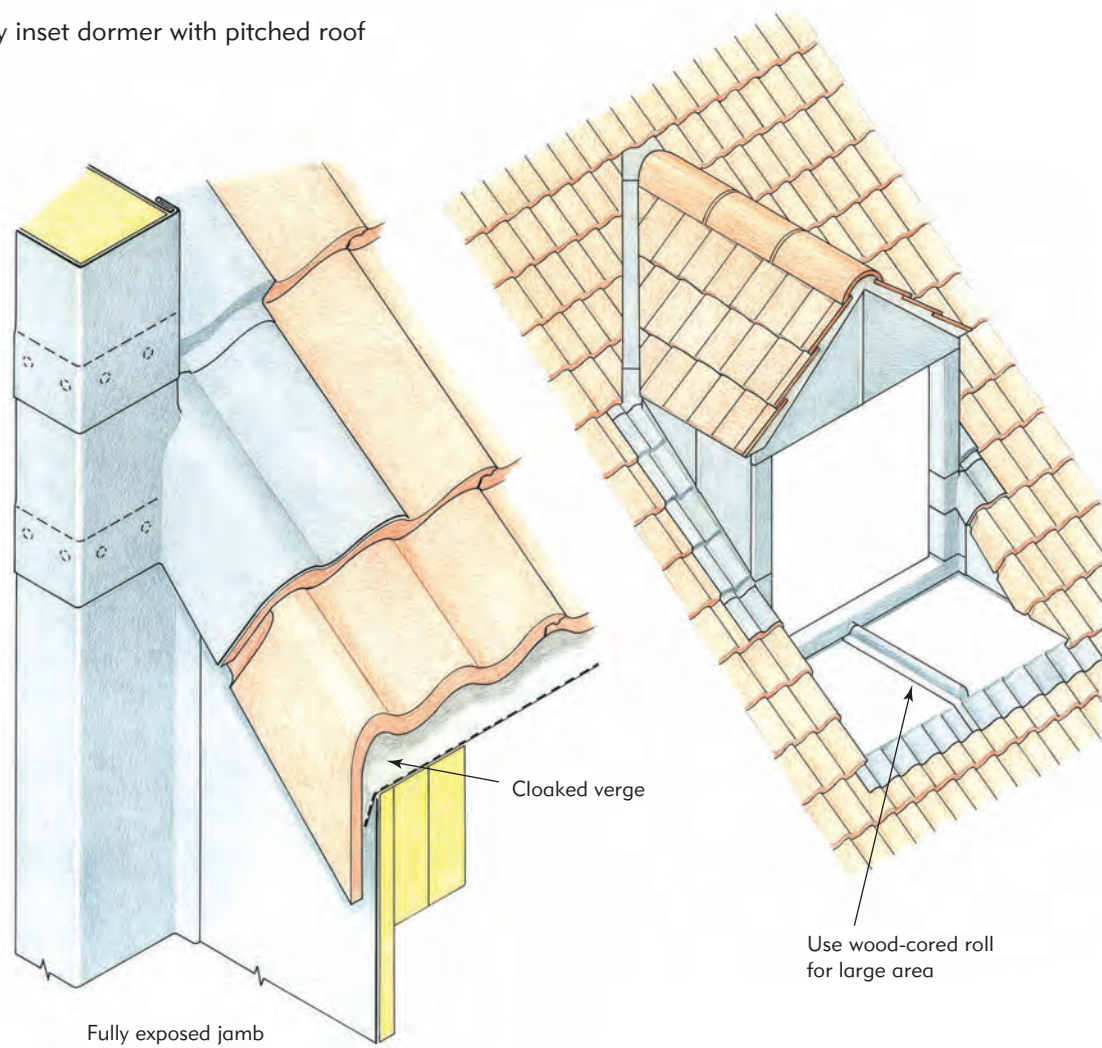


Fig 312. Partly inset dormer with flat roof



Dormer windows (cont.)

Fig 313. Partly inset dormer with pitched roof



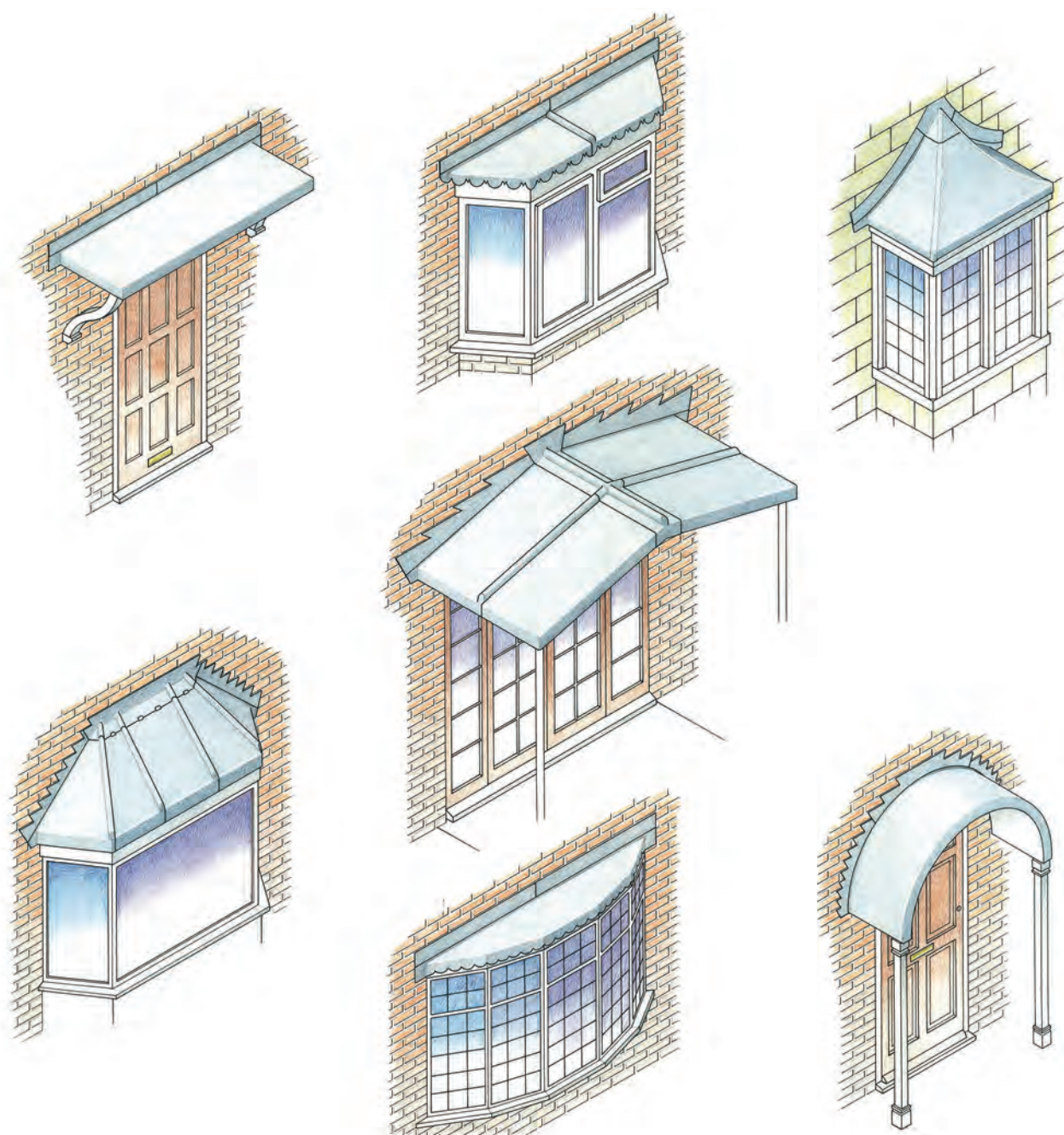
Door hoods and bay window tops

Fig 314 shows examples of lead-covered door hoods and window tops. Detailing of the weatherings for these applications will depend primarily on the size of the surface to be covered and the thickness of lead sheet specified for the work.

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

In some cases, joints are used to line up with window mullions, thereby making the individual pieces of lead considerably smaller than the recommended maximum size for the code used. Using smaller pieces is always an advantage, particularly where the panels are tapered towards the top and the fixing area is restricted. The front downstand of weatherings to door hoods and bay windows is often cut to a feature pattern (such as scalloping).

Fig 314. Door hoods and window tops



Door hoods and bay window tops (cont.)

When weathering flat-topped door hoods and bay windows, the maximum size of the pieces of lead sheet are as shown for single and two-piece dormer tops (Figs 298 and 299, page 185-186). Where a joint is required to divide a flat area, it should be a wood-cored roll.

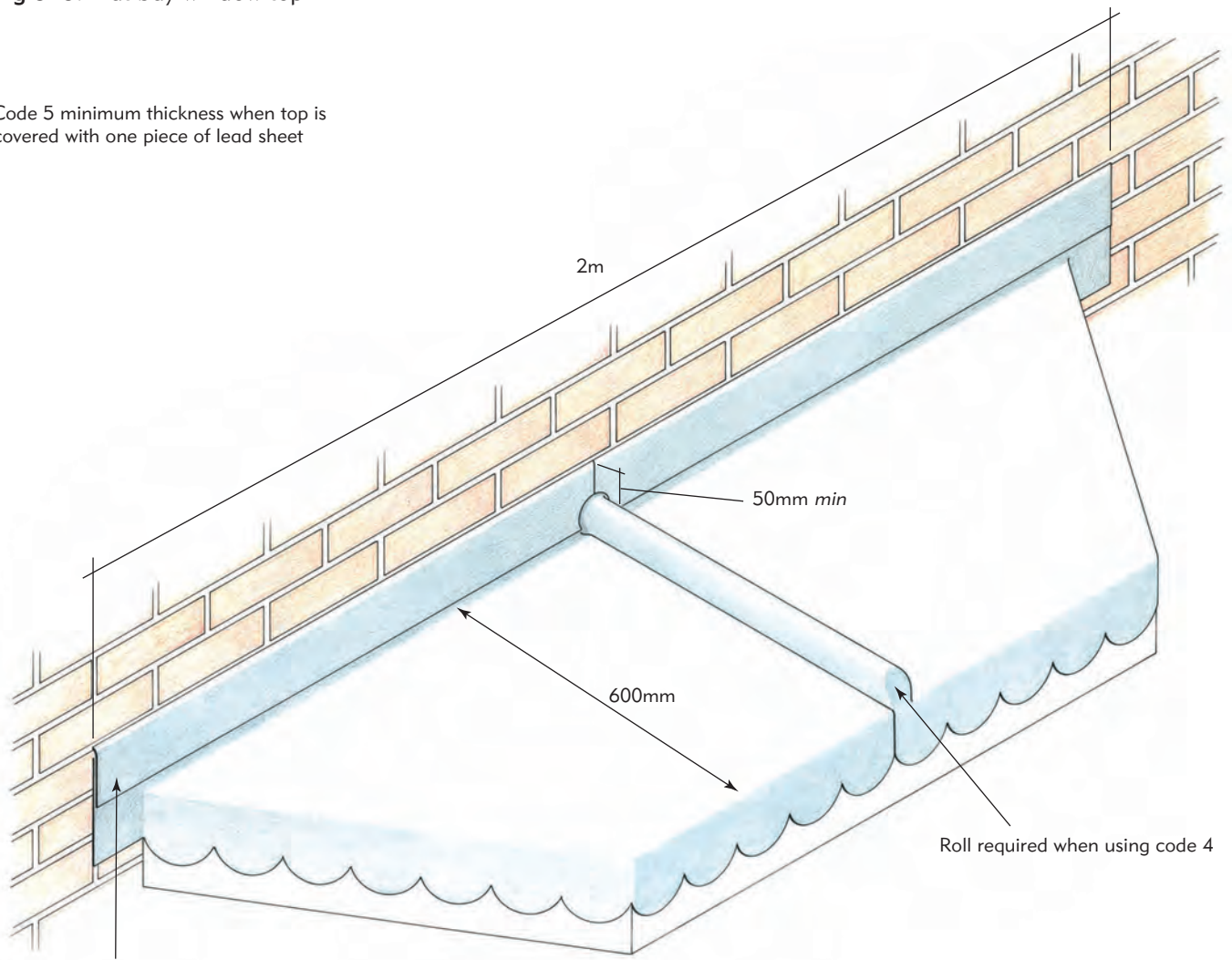
An example of a flat bay window top is shown in Fig 315. With an overall length of 2m and a projection of 600mm, a roll would be required if the top were covered with code 4 lead sheet. For code 5, the top could be covered in one piece without a roll because the size is within the maximum recommended for this thickness of material.

The upstand against the wall should be a minimum of 100mm. This will ensure that the cover over the upstand at the roll end is not less than 50mm.



Fig 315. Flat bay window top

Code 5 minimum thickness when top is covered with one piece of lead sheet



Cover flashing pieces must not exceed 1.5m in length

Door hoods and bay window tops (cont.)

For a small-pitched door hood, the weathering can be formed in one piece (Fig 316). However, for longer pitched surfaces, a separate bay is used on each side, with the upstand against the wall covered by a separate flashing (Fig 317).

A ridge roll is usually fixed at the apex, and where the projection exceeds 500mm for code 4 or 600mm for code 5, the area on each side of the ridge is divided with a roll. In sheltered to moderate exposures, a welt can be used instead of a roll if the pitch of the door hood is not less than 10°.

Fig 316. Small-pitched door hood

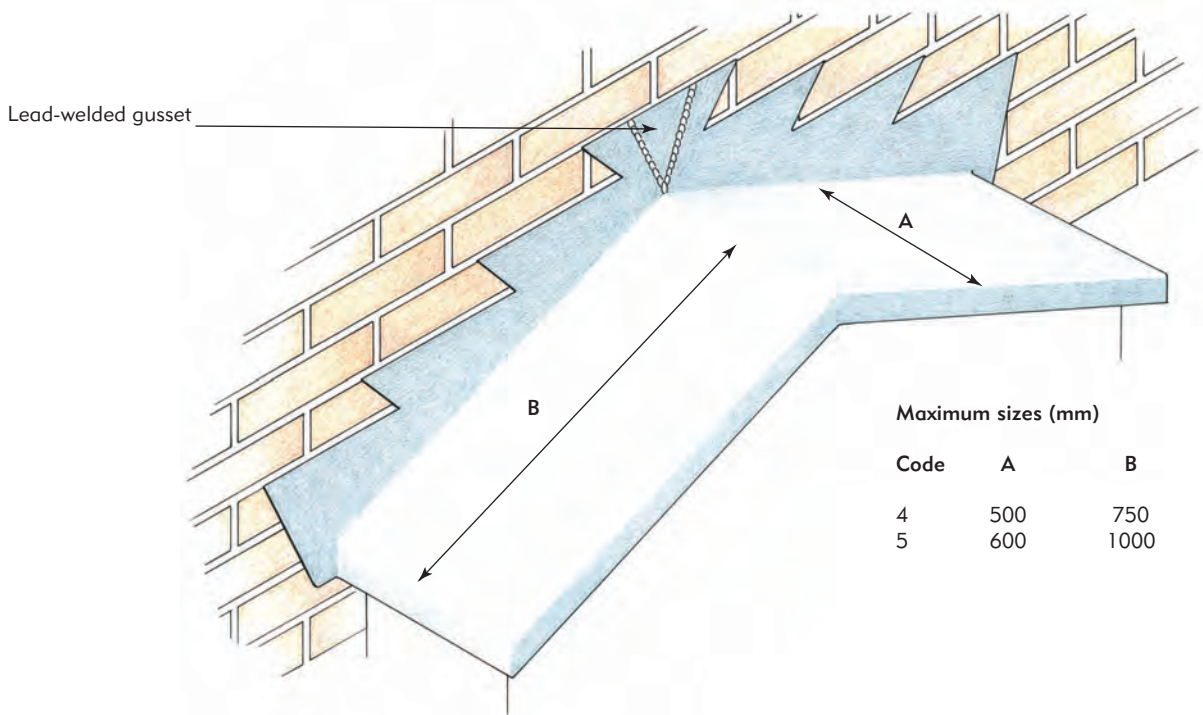
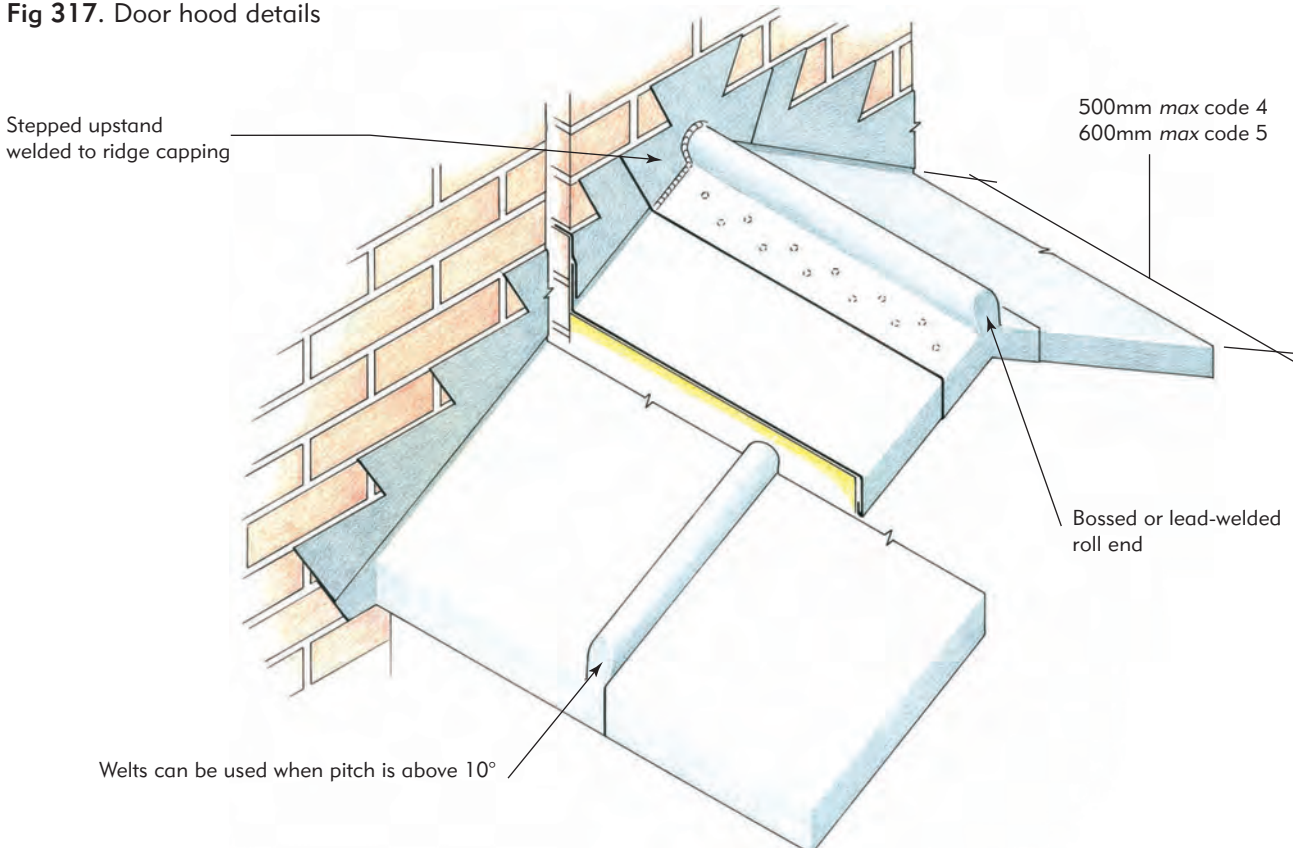


Fig 317. Door hood details



Door hoods and bay window tops (cont.)

With curved door hoods, the overall length around the curve and the depth of the projection will determine how many pieces of lead are required to cover the surface.

A small hood, not exceeding 2m around the curve or a 500mm projection from the wall, could be covered with one piece of code 4. If code 5 is used, these measurements can be increased to 2.6m x 600mm. The increase in length for both codes 4 and 5 is permissible because the pieces can expand in both directions. In many cases however, especially with semi-circular

hoods, it will be easier and more practical to use three pieces of lead to cover the hood with a lap joint on each side (Fig 318). In most cases, this will also allow wider projections to be covered without the use of welts. However, for large canopies (such as hotel entrances), welts or, in severe exposures, rolls will be required at a spacing to suit the thickness of lead sheet specified.

Fig 318. Curved door hood

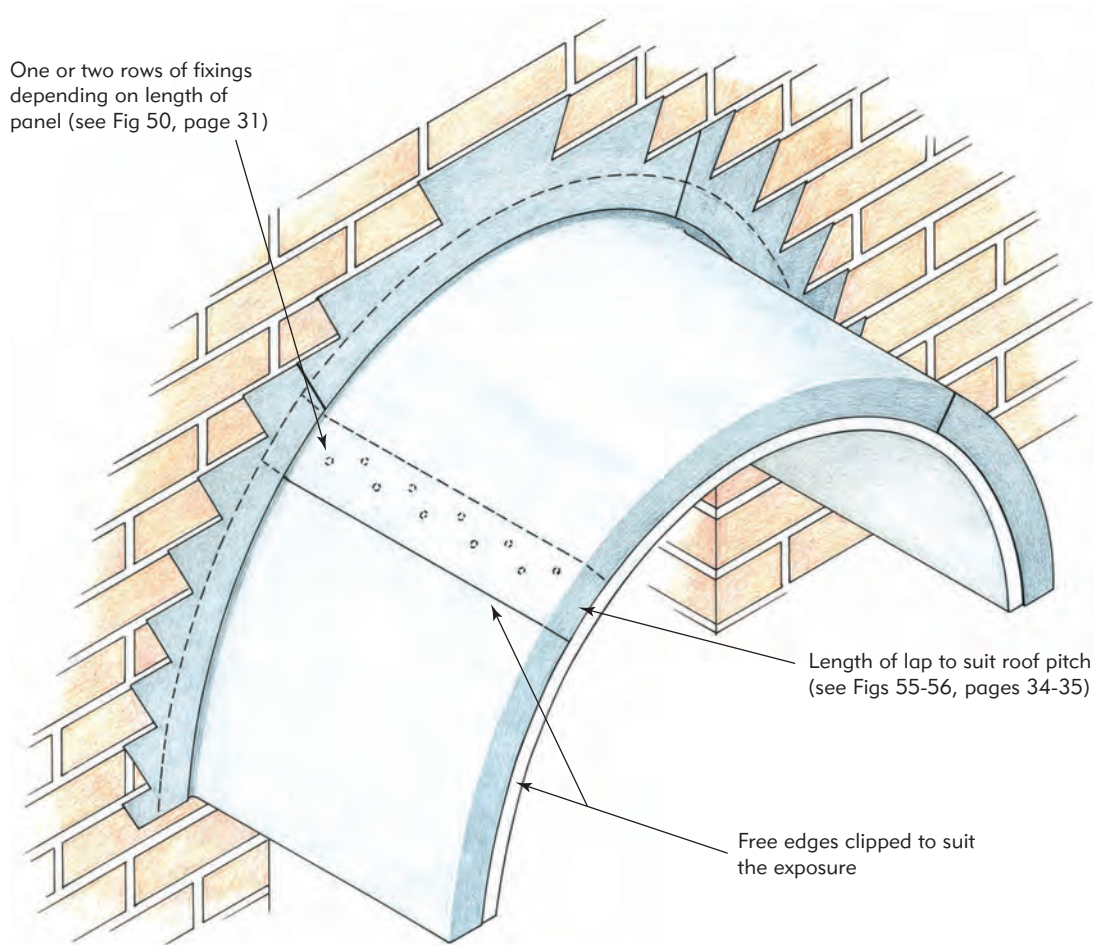
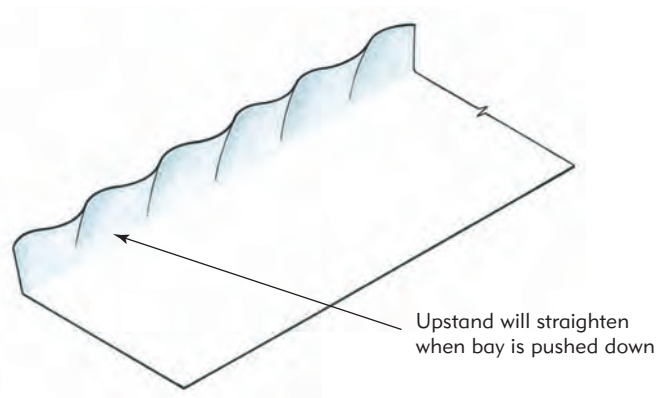


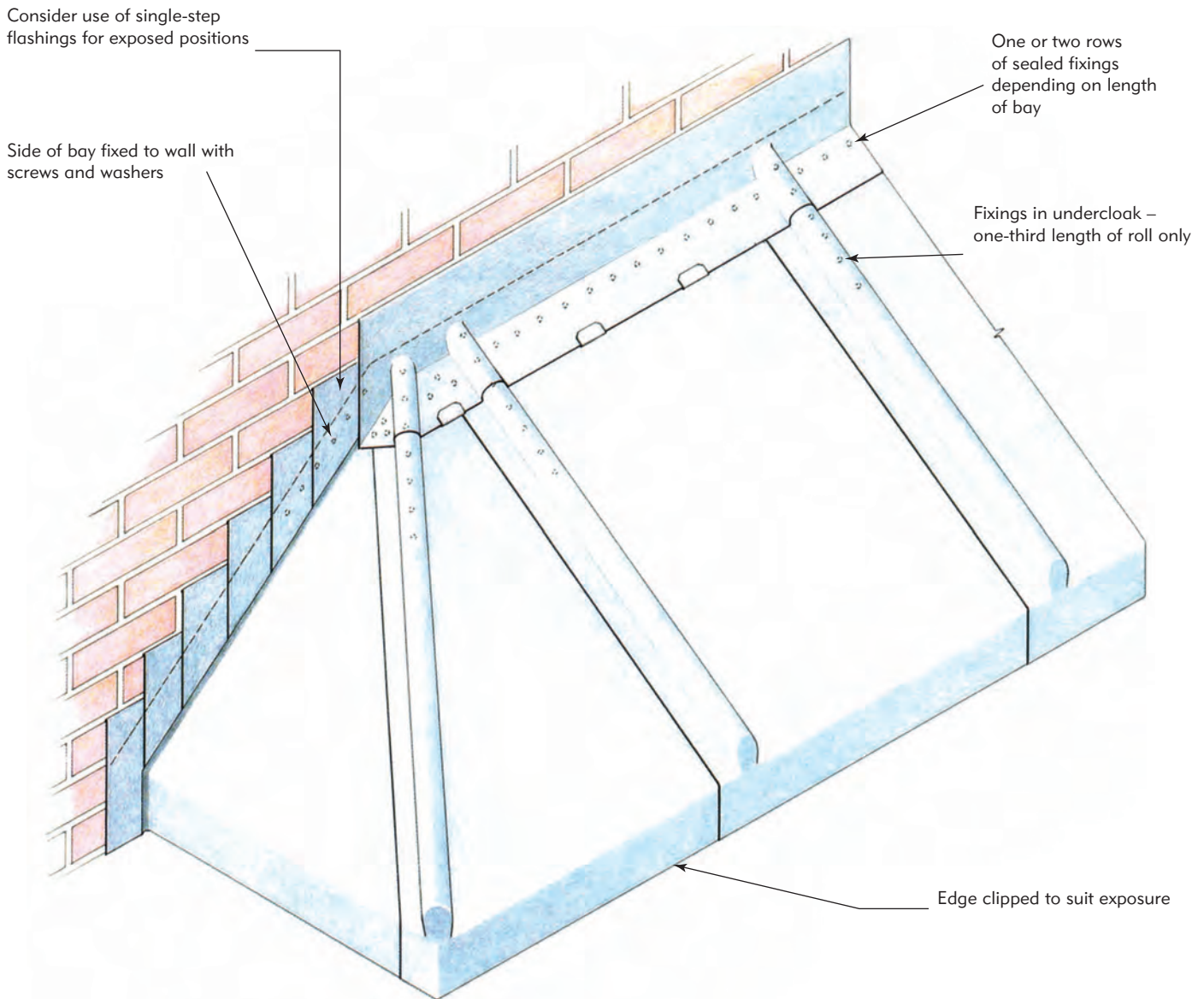
Fig 319. Method of curving bays

Fig 319 shows a method of stretching the upstand. With the use of two bossing mallets, corrugations are formed in the upstand that will straighten as the bay is pushed down to suit the curve of the hood. When covering a small semi-circular hood with one piece of lead, this method can cause unacceptable thinning of the upstand. Therefore, the use of a separate upstand welded to the edge of the curved bay will usually be more suitable. In all cases, the upstand is weathered by a separate cover flashing that, for both practical and economical reasons, is fitted in relatively short pieces.



Door hoods and bay window tops (cont.)

Fig 320. Pitched bay window top



For pitched bay window tops and door canopies, the joints with the fall can be either rolls or welts. With bay windows, the joints are often detailed to line up with the window mullions. The joints can be omitted, if necessary, provided that the individual pieces of lead sheet are within the maximum size for each code.

The most common cause of failure with lead weatherings to pitched surfaces is inadequate fixings. This is particularly the case where the pieces of lead sheet taper towards the top. Fig 320 shows part of a typical pitched bay window top. Fixing the parallel-sided bay in the centre of the window presents no problem because the fixing area is normal.

One row of nails at 50mm centres or two rows at 75mm centres, depending on the length of the bay, will hold the lead firmly and permanently in position. However, the two corner bays are tapered towards the top and it is not possible to provide sufficient nail fixings in the relatively small fixing area.

When using wood-cored rolls, fixings are positioned in the undercloak as shown and screws with washers can also be provided in the upstand against the wall. These fixings would normally provide adequate and permanent support for the tapered bays. Where welts are used instead of rolls, it is sometimes necessary to use intermediate fixings in the tapered bays to give additional support.

Door hoods and bay window tops (cont.)

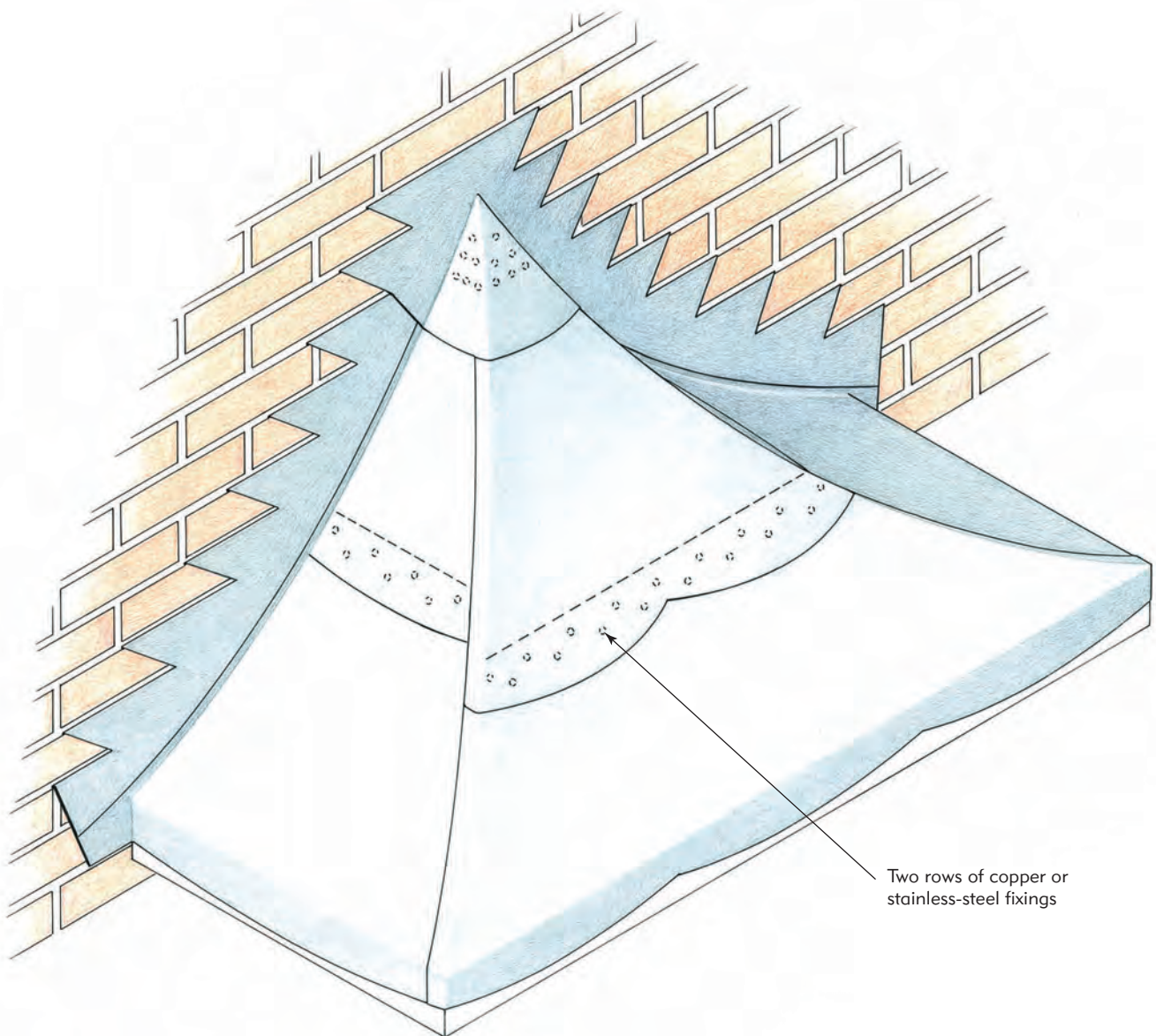
Another method of fixing is shown in Fig 321. The relatively few fixings at the top of the front panel of this door canopy are insufficient to hold the large tapered piece of lead permanently in position. However, by introducing a lap with two rows of fixings to hold the major section of lead, the head fixings at the apex will be sufficient to secure the smaller section adequately.

Normally, a lap would also be introduced into the side panels, although it is possible to provide adequate fixing for these sections by screwing the top third of the upstands to the wall.

At the top, the copper or stainless-steel fixings are covered by a stepped capping piece, which is usually fabricated by cutting and lead-welding on the bench.



Fig 321. Door canopy



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.

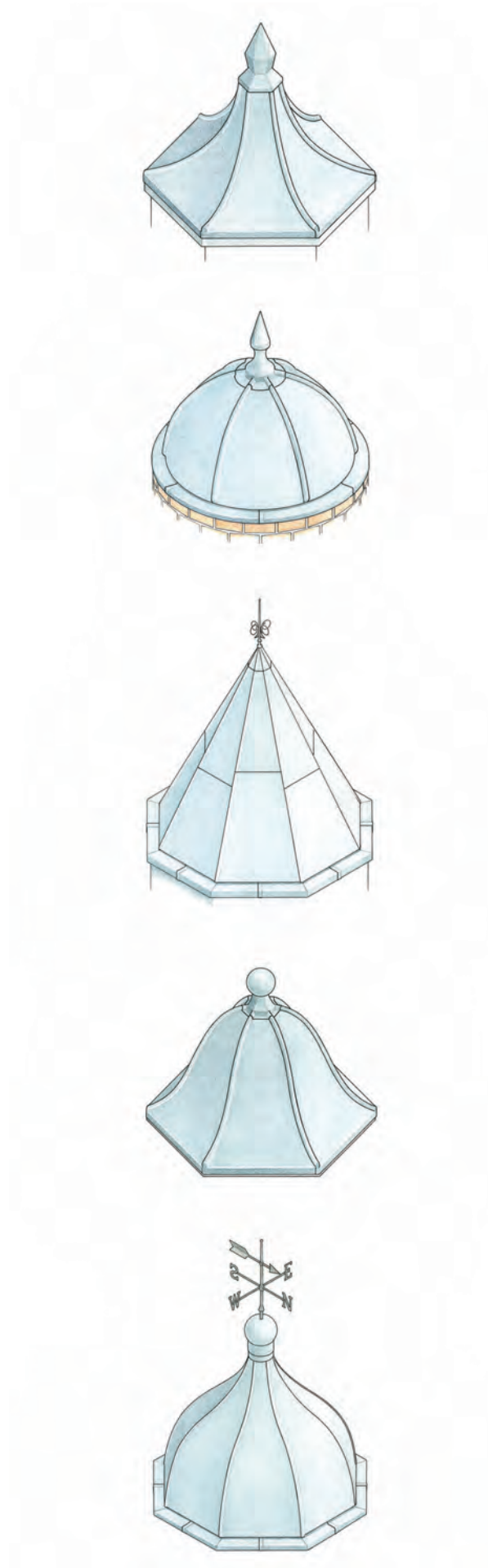
Fig 322 shows examples of small domes, turrets and spires. Joints between the panels of lead can be wood-cored or hollow rolls. Hollow rolls are particularly suitable for deeply concave or convex surfaces. Welts can also be used where the pitch of the contoured surface and exposure of the building will 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



Domes, turrets and spires (cont.)

Experience has shown that the most common cause of premature failure with lead weatherings to small domes, turrets and spires is slipping of the lead due to inadequate fixings. Fig 323a shows a typical small turret with panels of lead that cover the full length of the contoured roof slope. In most cases, the fixing area at the top of each tapered panel is not sufficient to allow adequate fixing to hold the weight of the lead permanently. Although the fixing clips in the joints on each side of the panel give some support, there is still the tendency in the long term for the lead to pull away from the head fixings and move downwards.

To prevent this, intermediate fixings (such as soldered dots) are often used in each piece of lead, but the positioning of these fixings could result in a restriction of free thermal movement and subsequent cracking around the fixing area.

Fig 323b shows the preferred method of weathering small domes, turrets etc. Each panel is divided into at least two pieces, depending on the length of the contoured slope and the thickness of lead sheet used. The relatively few fixings at the top will be sufficient to secure the smaller piece of lead permanently in position. The main section of weathering is supported by the usual two rows of copper or stainless-steel fixings. However, for very small areas it is sometimes possible to provide adequate head fixings to hold the bays securely, an example of which is shown in Fig 324.

If the joints between panels are wood-cored rolls, the head fixings positioned under the capping piece, together with fixings at 50mm centres in the top half of the undercloak, will usually be sufficient to hold the pieces of lead firmly and permanently in position. When using hollow rolls or welts, additional intermediate fixings in the top third of each panel will normally be required.

Fig 324. Small top with rolls

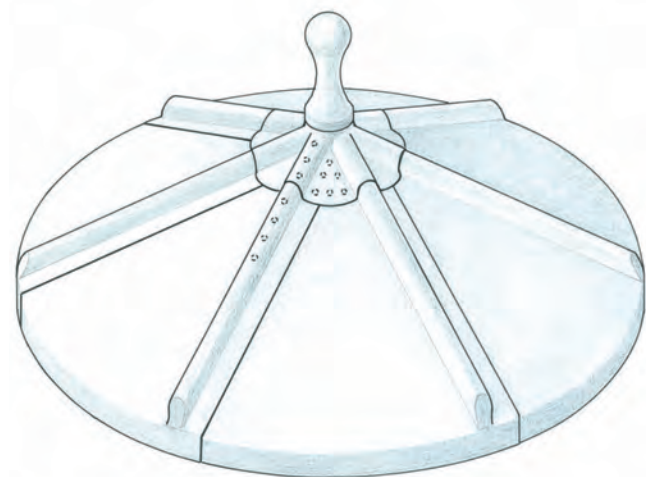
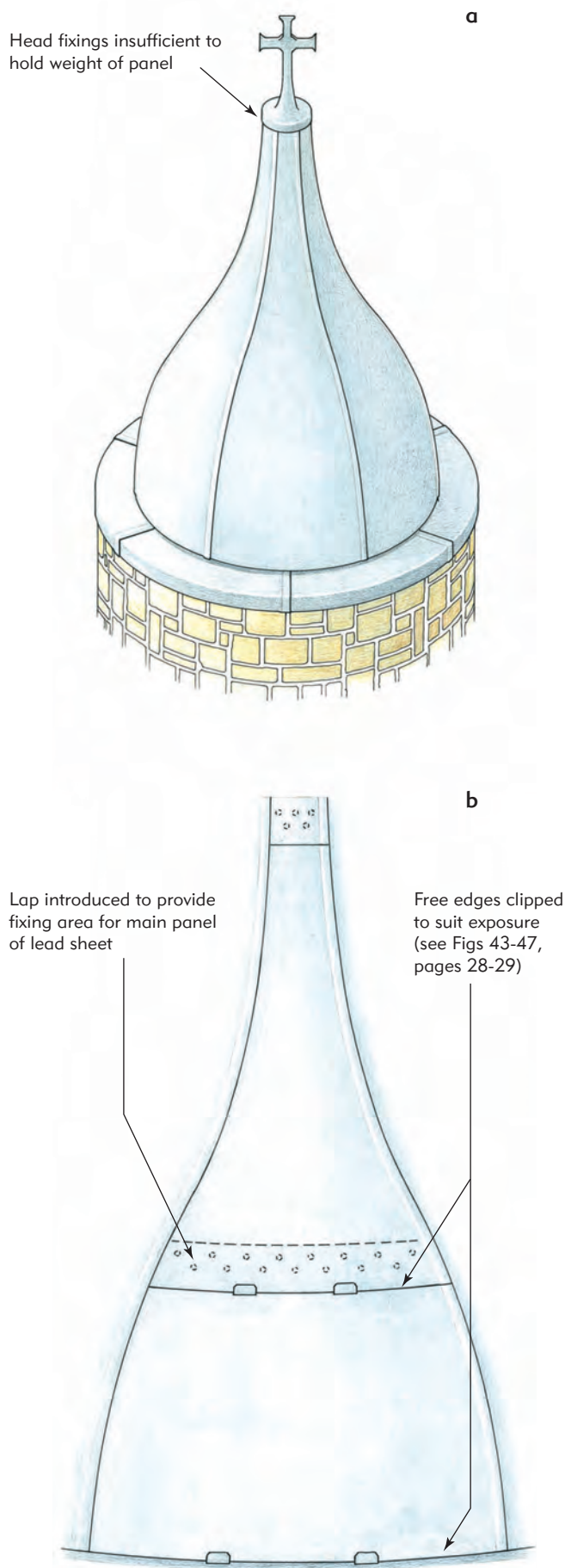


Fig 323. Fixing details



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