3.5 BUILT-UP ROOFING DETAIL DESIGN

INTRODUCTION

The formation of roof waterproofing details calls for a combination of the skills of the designer and the roofer. There are many different approaches to detail design and it is not possible to claim any one approach as the only correct method.

There are, however, fundamental principles of detail design which apply to all built-up roofing irrespective of the materials used.

At all skirtings and upstands, the waterproofing should be carried at least 150mm, and preferably between 150mm and 250mm, above the level of the finished roof, to protect against rain splash back.

At open edges, the waterproofing should be turned down at least 50mm. The only reliable alternative to this is to incorporate a parapet and coping.

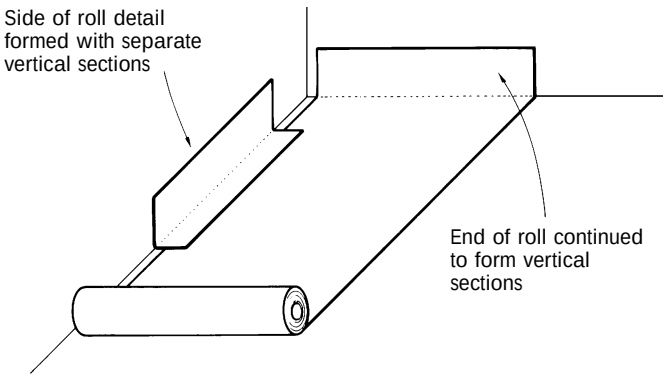
These minimum dimensions should not be overlooked or compromised because of other conflicting demands such as appearance or cost.

To illustrate the principles of the formation of details the following guidance assumes warm roof construction and the use of polyester based felts.

For proprietary materials, the instructions or recommendations of the manufacturers of the roofing materials should always be consulted for any special requirements.

SIDE OF ROLL AND END OF ROLL

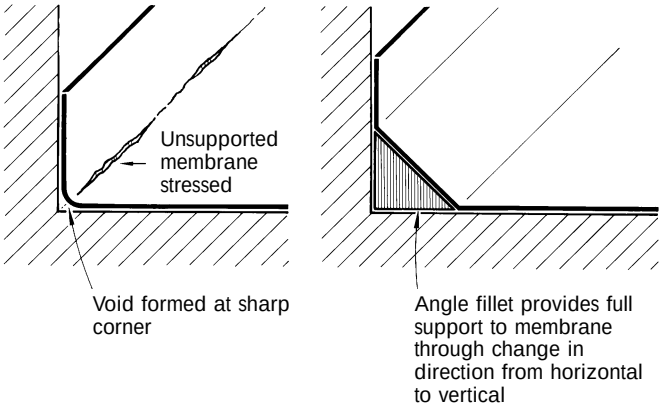
When considering built-up roofing details, there are two separate cases to be examined: the end of roll formation of details and the side of roll formation. At the end of roll, vertical sections of the detail can be formed by a continuation of the underlay. At the side of roll the roofing will usually be finished on the flat and the vertical sections of the detail will be inserted as extra pieces.



The end of roll detail is therefore easier to form, and roofers normally run the length of rolls along the shortest dimension of the roof. This gives them the maximum opportunity for carrying out the details at the end of roll.

FILLETS

A fillet is normally incorporated at the base angle of the upstand to take out the sharp corner and provide a satisfactory foundation for the upstand material. If a fillet is not provided, a void would frequently form between the waterproofing and the corner of the upstand.



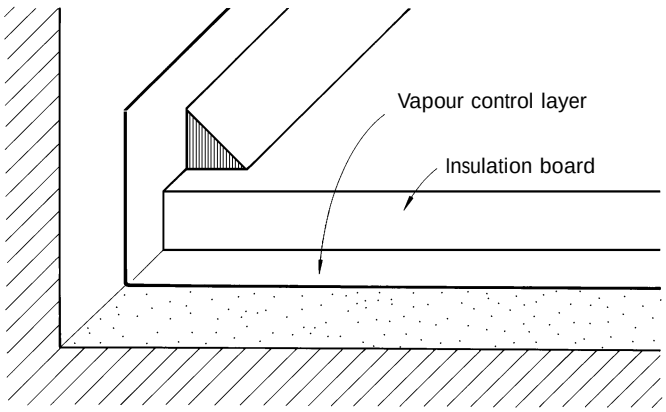
Preformed fillets of cork, rigid urethane or fibreboard are bonded into position with hot bitumen. Sand and cement fillets are generally only formed between concrete decks and brick or concrete walls. A 50mm by 50mm fillet is sufficient for most purposes.

SKIRTINGS

SKIRTING AT JUNCTION OF BRICK WALL AND CONCRETE DECK

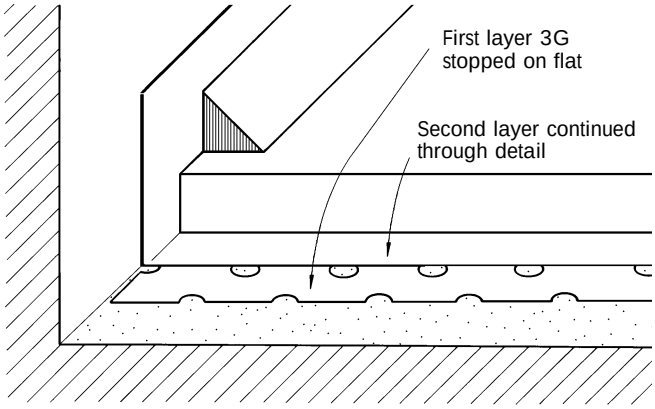
If there is no insulation on the roof deck, a fillet is introduced immediately and is bonded to the deck and to the wall with a continuous mopping of bitumen. The bitumen bonding also protects the fillet from dampness in the construction.

If insulation board is to be included and a vapour control layer is required, this layer should be taken through the detail to extend far enough above the fillet to enable the main waterproofing to be bonded to it and complete an envelope to the insulation. For the side of roll condition, it will be necessary to complete the layer with separate inserts for the vertical areas.



Single layer vapour control layer

A full vapour barrier, if required, should be applied with precautions to ensure that where necessary it is isolated from building movement. This will sometimes lead to the use of a two layer part bonded vapour barrier. The first layer will be BS 747 type 3G roofing, and for both side of roll and end of roll this layer should be finished on the flat. The second layer of the vapour barrier should continue through the detail and extend far enough above the fillet to allow the envelope to be completed.



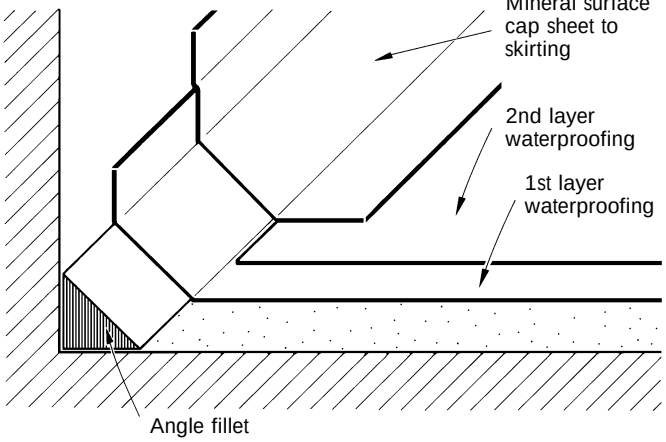
Two layer vapour barrier

FULLY BONDED WATERPROOFING

If the deck or insulation is one which will accept a fully bonded system it will be possible to carry the first layer of roofing straight up the skirting at the end of roll condition, with the top layer mineral surface cap sheet applied as a separate piece.

It is usual to complete the upstand with staggered layers of roofing to prevent a thick ledge forming at the top of the upstand. The staggered formation is also more stable against slipping and slumping and the thinning of the waterproofing at the top of the upstand causes no problems.

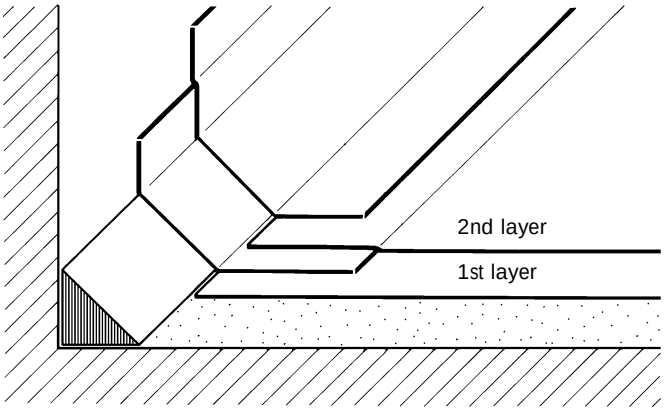
End of roll condition



Fully bonded specification

The layers of waterproofing at the side of roll will finish on the horizontal and it will be necessary to complete the layers through the detail with separate pieces.

Side of roll condition

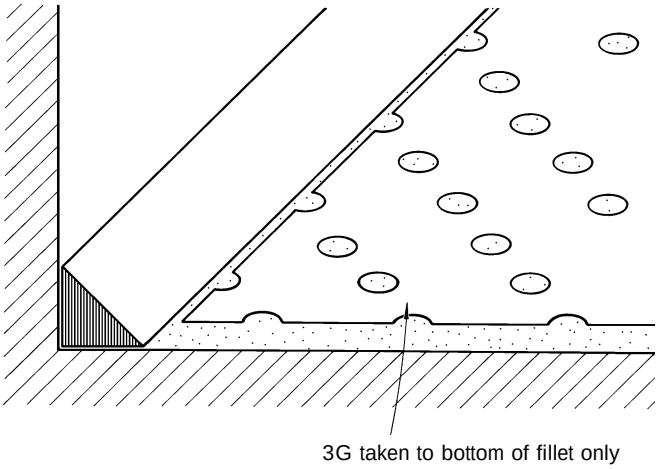


Fully bonded specification

PARTIALLY BONDED WATERPROOFING

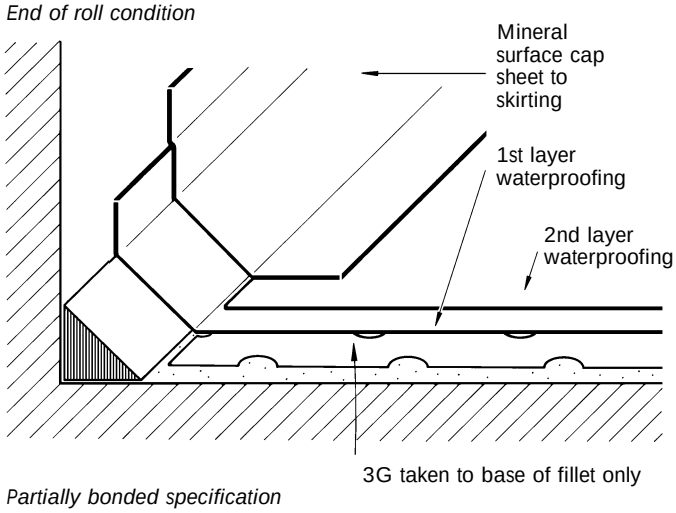
If the deck or insulation requires a partial bond system, this will probably be achieved by a layer of BS 747 type 3G perforated roofing.

To prevent wind damage, the edges of the roof must be closed off against the entry of air to the underside of the waterproofing and it is therefore necessary to fully bond all the layers of the detail work to the substrate. Type 3G is only suitable for application to horizontal areas and is always stopped at the base of the skirting.



At the end of roll condition the first high performance layer will be continued up the skirting without a break, with the top layer of mineral surface cap sheet applied as a separate piece.

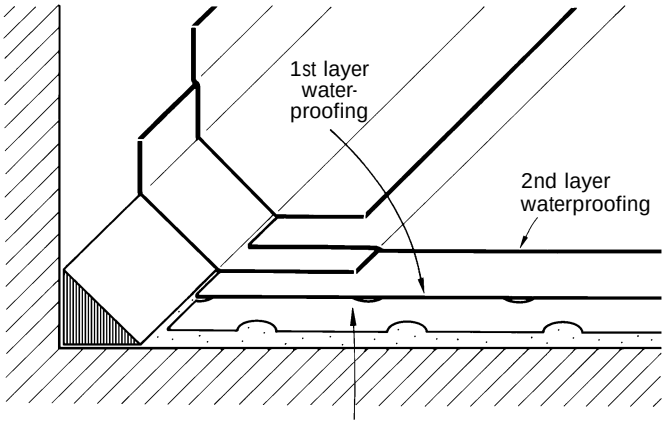
End of roll condition



Partially bonded specification

At the side of roll condition, all layers of waterproofing are finished on the horizontal and the continuation through the detail is formed with separate pieces.

Side of roll condition



Partially bonded specification 3G taken to base of fillet only

A protective surfacing at skirtings is normally achieved by the use of a mineral surfaced roofing for the final layer. This extends on to the horizontal area for approximately 100mm and is continued up to the level of a cover flashing which is set underneath the damp proof course in the brickwork.

Skirtings which exceed a height of 300mm should be head nailed.

If chippings are specified they may be stopped at the bottom of the fillet.

To reduce thermal bridging it may be necessary to add insulation behind the skirting, or to substitute insulating blockwork in lieu of brickwork.

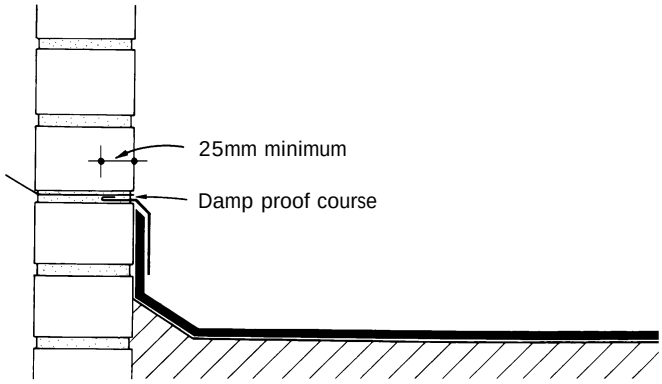
METAL COVER FLASHINGS

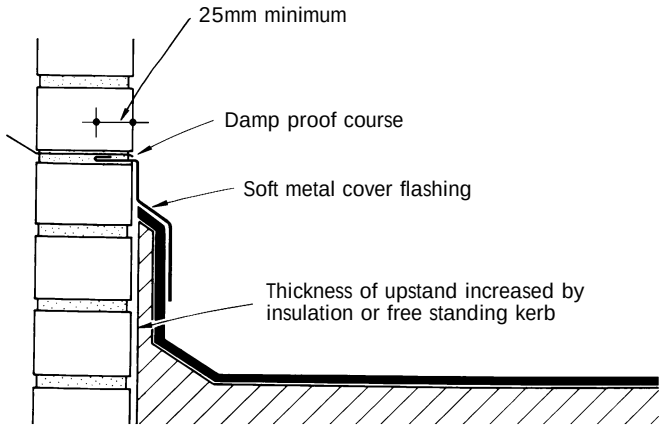
Lead is the traditional and most successful flashing material, but is too often ruled out on the grounds of cost. Lead weathers well in most localities and allows for movement in relation to the upstand which it covers. It is easily dressed down over the finished waterproofing and turned back for inspection and remedial work. Individual lengths of lead should be limited to 1.5m. Copper or super-purity aluminium are used as alternatives, but they cannot rival lead for the combined virtues of ductility, weathering and corrosion resistance.

The metal cover flashing is normally positioned immediately under the damp proof course, and set a minimum 25mm into the wall. It is good practice to build it into the wall under the dpc during construction.

With the majority of built-up roofing specifications, the top of the upstand will be thinned by the staggered formation of the materials and a ledge will not be formed at the top of the flashing. If the full thickness of waterproofing is maintained at the top of the upstand or if the thickness is increased by the addition of insulation or a free standing kerb, a ledge may be formed which might hold water. To avoid this, the flashing should enter the wall one course higher than the top of the upstand. It will be necessary to take this into account when setting the level for the dpc at design stage.

If a metal flashing is to be installed after completion of the walls, a chase will have to be cut beneath the dpc and the cover flashing held with wedges and sand and cement pointing.





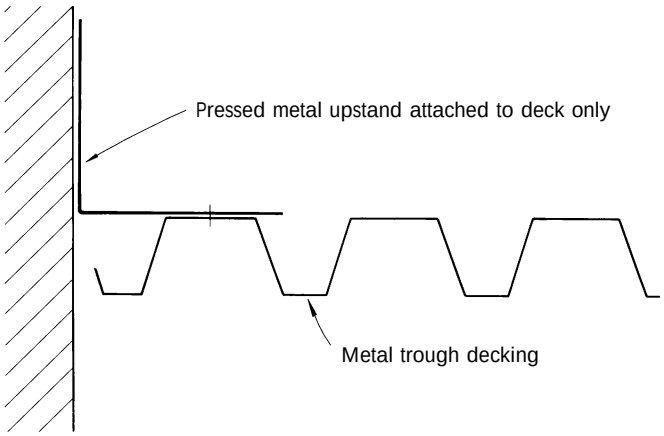
If a metal cover flashing is not included, the high performance mineral surfaced roofing is turned into the chase and held in position by sand and cement pointing.

A similar arrangement using separate mineral surfaced flashing pieces applies when the waterproofing is taken over a low parapet wall to form a capping, or is dressed over an eaves check kerb.

SKIRTING AT JUNCTION OF METAL DECKING AND BRICK WALL

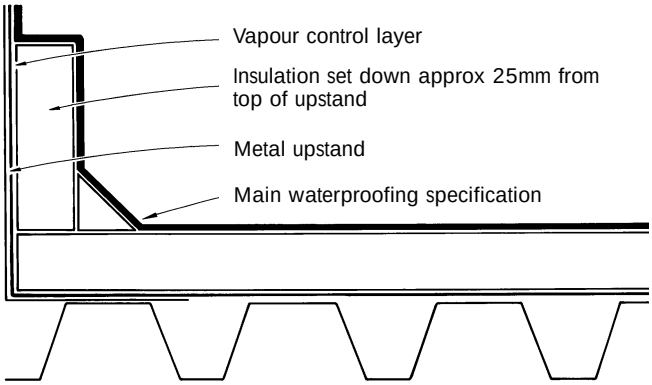
At the junction between a metal deck on a steel frame and a brick wall which is independent of the steel frame, differential movement between the roof and the wall can be expected and an independent upstand will be required.

The independent upstand can be formed by metal angles attached to the deck.

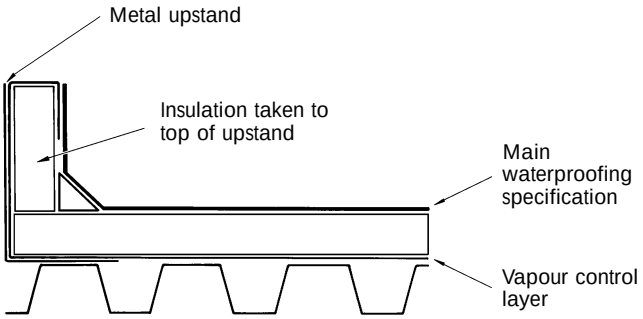


The vapour control layer should be taken through to the top of the metal upstand. At the side of roll condition, the layer is completed to the top of the upstand with separate pieces.

The insulation may be set down from the top edge of the metal upstand by about 25mm. This will allow the waterproofing to complete an envelope around the insulation and provide protection from rain splash. The envelope should always be completed if a vapour barrier is specified and the top edge is exposed to the internal environment.



An alternative is to bring the vapour barrier layer over the top and onto the front face of the insulation which, in this case, will be continued to the top of the metal upstand.



If the insulation board selected for the main horizontal areas of the roof requires a partially bonded first layer, it is advisable to change the insulation at the upstand to one which will accept a full bitumen bond. The waterproofing should not be applied direct to the metal upstand due to the risk of splitting at joints in the metal.

A metal cover flashing is essential to allow for the movement between roof and wall, and this should enter the wall one course higher than the top of the upstand, so that the flashing can be dressed more easily over the upstand without forming a ledge which might hold water.

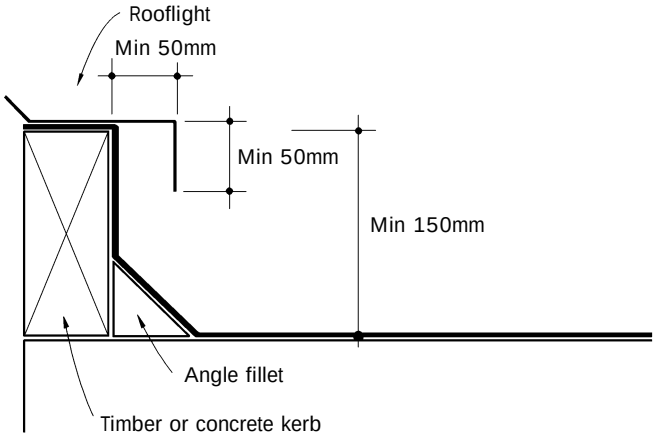
FIXED UPSTANDS AND KERBS

The majority of skirtings on metal deck roofs are formed by metal upstands fixed to the deck and to the structural frame or cladding members. The formation of skirtings is exactly the same as for independent upstands described above.

The principles so far discussed for skirtings apply equally well to ventilators and rooflights and to similar items set on kerbs above the general level of the roof. The termination of the waterproofing and the flashing arrangements will, however, vary according to the nature of the kerb.

TIMBER AND CONCRETE KERBS

The first layer of the waterproofing specification will be bitumen bonded to the majority of upstands but should be nailed to large areas of timber to avoid blistering and the effects of movement. The waterproofing should be taken over the top of the kerb. The ventilator or rooflight should include an integral flashing with a 50mm turndown to provide reasonable protection to the upstand and 50mm clearance for the roofing, to allow repair work to be carried out without disturbing the flashing. A flashing which is deeper or which projects less than this should not be incorporated in the design unless it is easily removable.

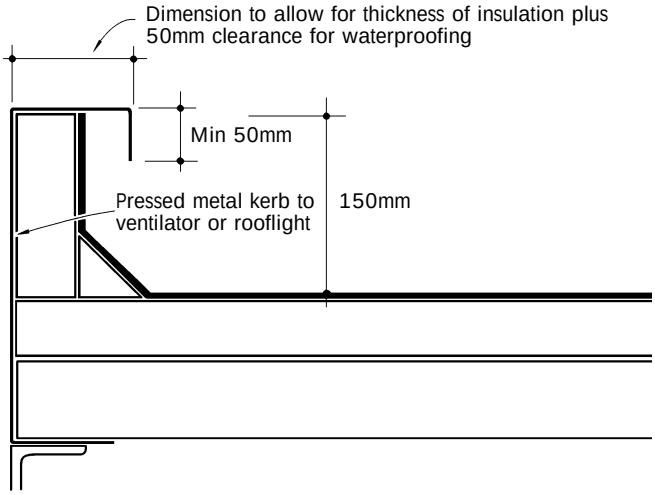


The waterproofing at the corners of a kerb is formed by allowing each individual upstand piece to project past the corner when it is positioned. The projecting part is then cut into flaps, leaving one flap for each flat surface which forms the detail. These are then turned round the corner and bonded in bitumen.

The process is repeated for each upstand piece. For the final mineral surface cap sheet, the first piece is cut as before but the second piece is cut on the mitre. This results in a substantial thickening of the specification at the corners and the clearance of the flashing must be sufficient to avoid cutting into the waterproofing, hence the need for a 50mm clearance.

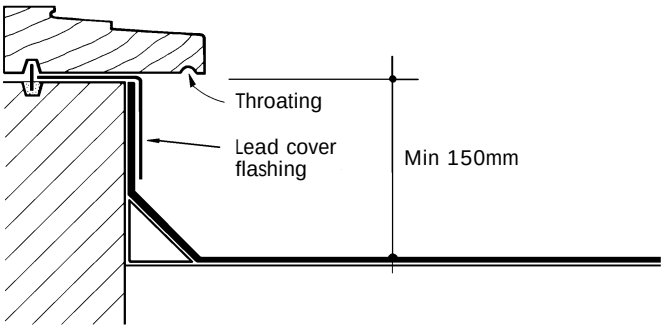
METAL KERBS

Metal kerbs are frequently installed on a metal deck to support ventilators and rooflights. The kerbs should be designed to incorporate a projecting flashing which should allow for the thickness of the insulation, and a further 50mm clearance for the waterproofing. The flashing should be approximately 50mm deep to allow a good cover to the upstand and plenty of working space for the roofer. The waterproofing cannot be turned over the top of the kerb and secured. It is therefore not desirable to have such kerbs higher than 150mm above the level of the roof. If substantially higher upstands are essential, it will be necessary to add a timber batten at the top in place of the insulation to provide a position for nailing the waterproofing at the top of the upstand.



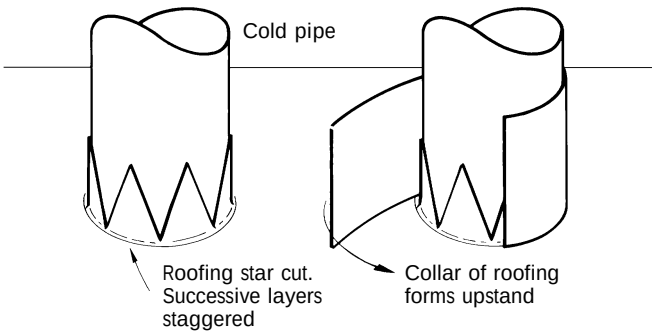
SKIRTINGS TO THRESHOLDS AND CILLS

Thresholds and cills leading on to a flat roof should allow a 150mm upstand. A lead cover flashing under a threshold cill and throating forms the most satisfactory detail.



SKIRTINGS TO COLD PIPES

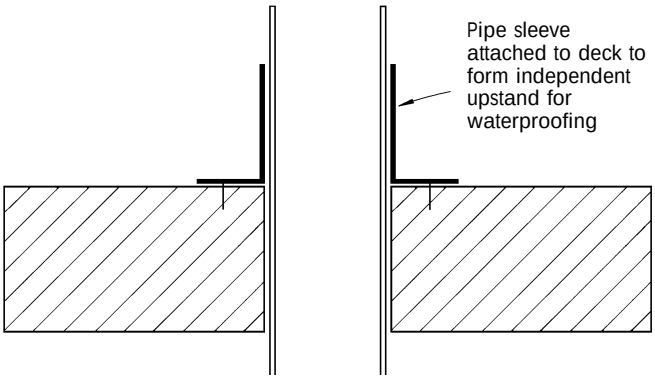
Upstands to pipes are a form of skirting but the technique of application generally requires star cutting of the underlays to form the base of the upstands, and collars to form the upstand itself.



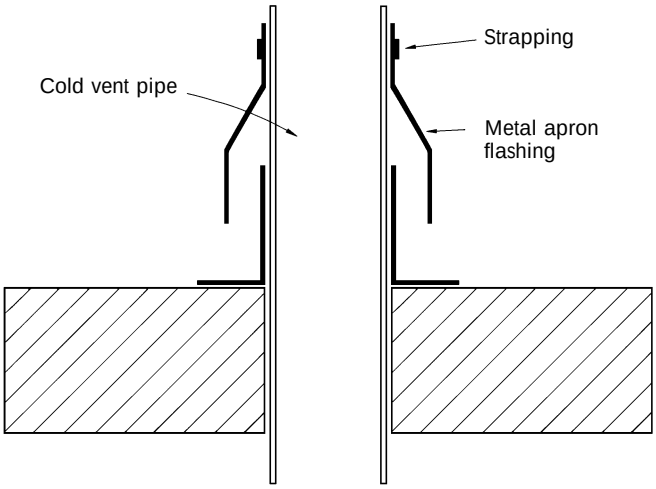
The principle of forming star cuts and collars applies to the treatment of a vapour control layer around penetrations but for an underlay or vapour check beneath insulation, it will be sufficient to cut the felt and insulation close to the projection. The bonding bitumen used will fill the voids and will provide sufficient protection.

If a cold metal pipe is firm in relation to the roof deck, there should be no need to form an independent upstand. It is common practice for a cold pipe to be left with no further flashing arrangement, leaving the seal of the waterproofing to the pipe as the only safeguard. This is generally satisfactory but an independent flashing or cowl secured to the pipe is preferred.

A pipe sleeve will be necessary to form an independent upstand if differential movement is expected between the pipe and the deck. In this case an independent flashing or cowl will be essential.



An independent flashing on a cold vent pipe may be formed by strapping and caulking a short metal apron into position. Proprietary pipe sleeves are available with integral weathering collars which prove very satisfactory.

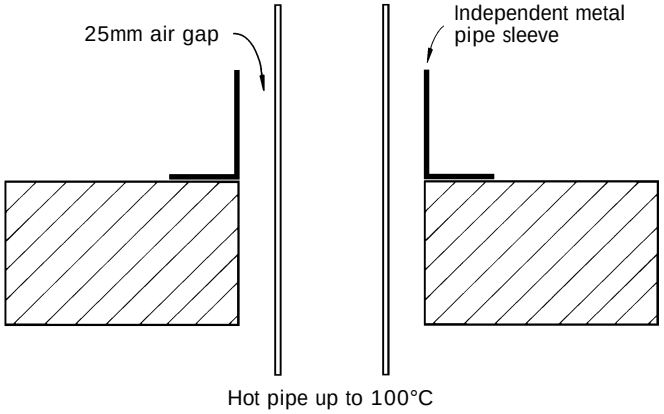


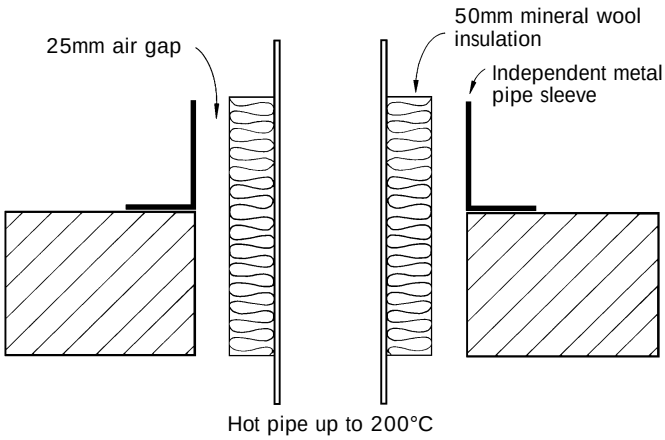
SKIRTINGS TO HOT PIPES AND FLUES

Bitumen roofing should not be applied direct to hot pipes or flues. Hot pipes must have an independent sleeve with a separating air space or insulation between the sleeve and the pipe. A 25mm air gap will suffice for pipe temperatures up to approximately 100°C. Above this temperature it is necessary to add insulation. As a rough guide, a 25mm air gap and 50mm mineral wool insulation will be needed for temperatures up to 200°C.

Large industrial flues require kerbs constructed of concrete or insulated metal. Ventilation should be allowed between the flue and the kerbs. The insulation must be non-combustible and the flue or the flashing should be removable to allow access for repair work.

Where temperatures are so high that the use of combustible material could form a fire risk, the insulation, waterproofing and any combustible deck should be set well back from the flue, and the space made good with a large cowl.

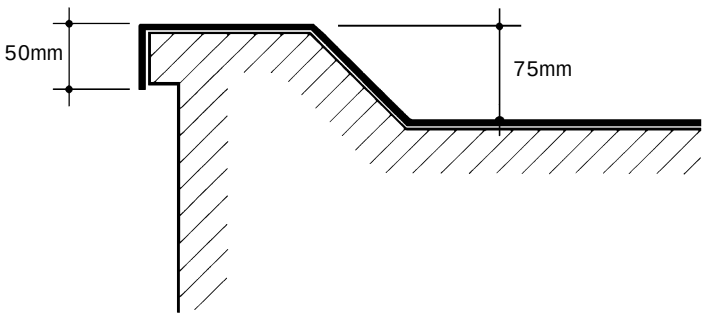




EAVES AND VERGES

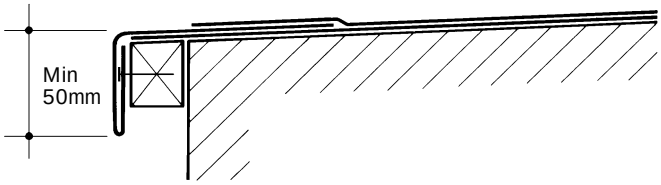
Where the waterproofing is taken over the edge of a roof, either as a drip into an external gutter, or to form a weathering edge to a kerb, there should be a minimum 50mm turndown of the waterproofing.

On the gable ends of a roof, some form of edge upstand or check kerb should be provided to prevent blown water spilling over the edges. The height of check kerb required to prevent overspill will depend on the degree of exposure of the roof, the roof pitch and the shape of the upstand. A height of 50mm to 75mm would normally be sufficient, and an angle of approximately 45° for the upstand face will avoid sharp changes in direction of the waterproofing.



WELTED DRIPS

Welted drips of mineral surfaced roofing are a traditional and reliable edge detail for the eaves and verges. Designers frequently discount their use on grounds of appearance or fashion, but the welted drip is favoured by many roofers as the most satisfactory way of forming a drip into an external gutter, or to weather the edge of a kerb.



2 layer specification

Welted drips are traditionally formed on timber battens to throw the rainwater clear from the fascia. Strips of roofing are cut from the roll and folded into shape to form the minimum 50mm downturn. The roofing is normally nailed to the timber batten, bonded to form a drip and returned on to the roof surface to be interleaved with the waterproofing.

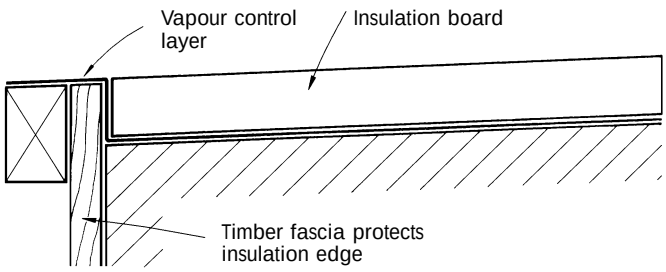
A hardboard or plywood former may be nailed into position as a guide for the folding of the drip. This helps to ensure a straight edge and adds security against high winds.

The drip is best made with SBS modified mineral surfaced roofing, polyester 180 or 250.

The formation of the drip requires craft skills for the hot bitumen bonding of the folded materials and the shaping of the edges of the roofing strip to accommodate the side laps without unsightly bulges at the roof edge. There are a number of ways of shaping the edges of the strips of roofing to avoid this but an increased thickening will occur along the roof edge. Small amounts of water may be held back after rainfall, but this will not have a detrimental effect on the performance of the detail.

On concrete or brick kerbs, timber plates should be incorporated with a 25mm minimum overhang. The detail then follows normal practice with the welted drip formed after the upstand detail.

Where insulation extends to the roof edge, it will be necessary to provide firm support for the waterproofing and to protect the vulnerable roof edge of the insulation from damage by ladders and other maintenance traffic. This can be achieved in a variety of ways. For example a timber fascia can be extended upwards to the correct height to form a stop for the insulation to butt against.

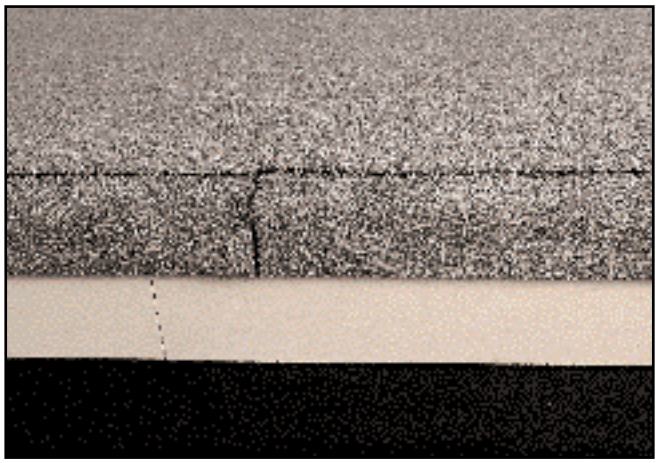


If a vapour control layer is required, this should be taken up and over the edge to allow the waterproofing to complete an envelope around the insulation.

Folding and forming the welt (1)

Folding and forming the welt (2)

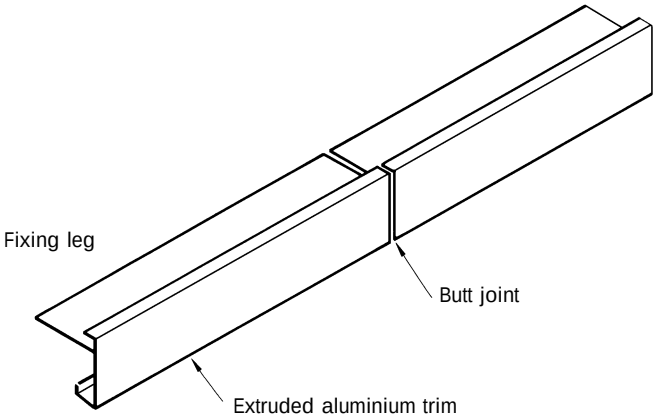
Folding and forming the welt (3)



Completed drip

EDGE TRIMS

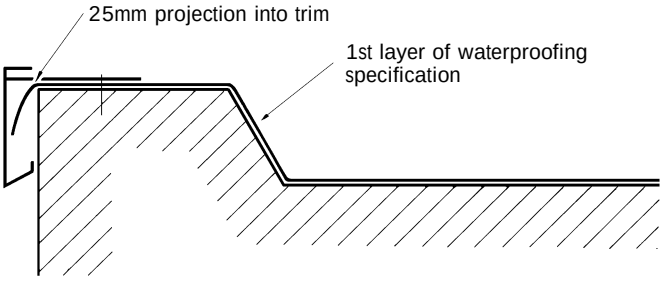
The most common form of edge trim is the single piece extruded aluminium or GRP trim. Many proprietary forms are available, and whilst there are differences in the design they all work on the same butt jointing principle. They are designed for use on kerbs and are not usually suitable for a drip into a gutter due to the raised portion of the extrusion which encloses the leading edge of the membrane.



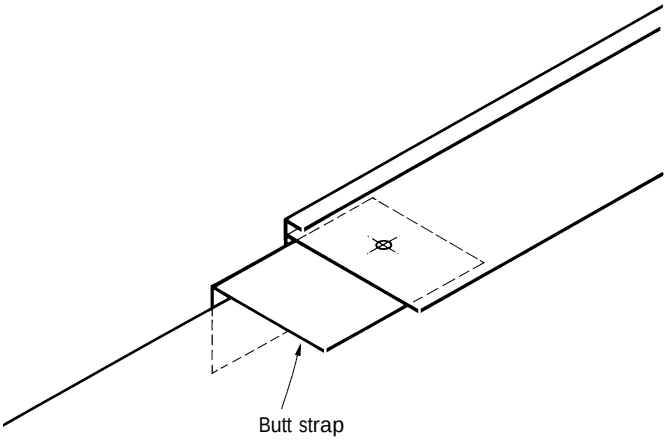
Grounds must be provided for the trim and these grounds must themselves be firmly fixed to the structure. The grounds may be timber plates, timber inserts, or metal closures and kerbs in conjunction with metal deck. It is possible to fix direct to good quality concrete by drilling and plugging, but in this case the trim must have a large back leg to allow the fixing to be sufficiently far back from the edge to prevent spalling. 50mm back from the roof edge is generally sufficient but site trials will also be necessary to establish the most satisfactory fixing method.

Edge trims should only be fixed directly to brickwork when the bricks, their bond and the fixing of the trim are proved sound by site trials. Otherwise, a timber plate should be firmly strapped to the top of the wall to provide a fixing. In general, brickwork does not provide a good fixing for metal trims and a traditional parapet and coping is preferable.

The waterproofing of the trim system depends on an efficient seal of the roofing to the horizontal leg of the trim and this should be primed and dry before application of the roofing. Before fixing the metal trim, the first layer of the waterproofing specification is taken across the kerb to project about 25mm. This acts as a final line of defence to deflect any small amount of rainwater which might pass through the butt joint system and ensures that the water falls clear of the outer face of the building.



The trim should incorporate butt straps, which are close fitting to the underside of the joint. The straps may be supplied loose or fixed at one end of the trim. If supplied loose, the end fixing of the trim should pass through the end of the butt strap.



The edge trim of a roof is always vulnerable to wind damage, and a good principle is to fasten the trims with screw fixings at 300mm centres with additional fixings in positions of extreme exposure.

High performance roofings generally behave well when made good to edge trims, but some distortion above the butt joint may occur.

The temperature range for self-finished light coloured aluminium trims in service is likely to be from -10°C to 60°C, and the free expansion and contraction of 3m lengths of aluminium trim over this range is 5mm. In practice, the movement of the trim will be restricted by the fixings, but if no allowance is made for expansion at the joints there is the danger of buckling of the face of the trim. A gap of 2mm at the butt joints proves to be sufficient in practice.

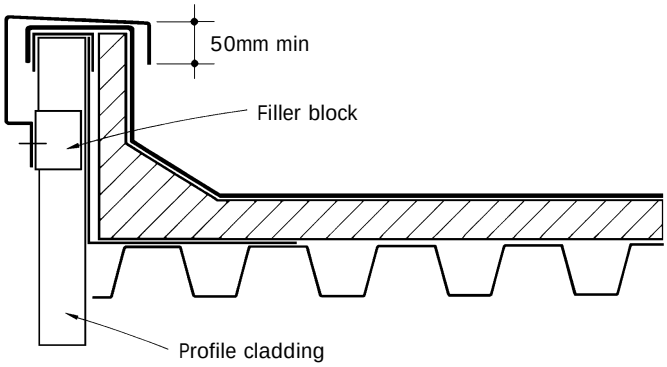
LEAD TRIMS AND FASCIA FLASHINGS

Lead trims are not widely used although they normally prove satisfactory. They form the best and perhaps the only satisfactory means of cloaking slates or tiles at the top of a mansard roof. Built-up roofing should not be made good directly to lead. The lead should be finished with a vertical face, and the felt taken down over the lead in the form of a drip edge on a timber batten. A mineral surfaced welted drip is preferred.

The lead should be fixed at close centres and tightly dressed to the slates or tiles. The maximum length of lead should be in the order of 1.5 metres to minimise movement at the joints of the lead.

CAPPINGS

A common detail for buildings with metal decking and profiled cladding is to take the vertical cladding up above roof level to form a dwarf parapet. The fascia trim will probably match the colour of the cladding and be of similar material. This detail combines the trim detail with a flashing detail, and the conventional principles apply. The 50mm turndown is required as usual and a 50mm space for the membrane.



The top of the flashing should have a slope or haunching to prevent standing water on the top, which would find any weakness at the butt joints or fixing points. The water may also act as a lens for the sun and can lead to premature breakdown of the coating.

Cappings are particularly vulnerable to the wind and will require fixing on the front face and the top surface, both at approximately 300mm centres.

GUTTERS

LINED GUTTERS

Lined gutters are best avoided on a flat roof. When it is considered essential to incorporate gutters, the formation of the membrane in the gutter is equivalent to a narrow roof with kerbs on either side installed with an end of roll formation.

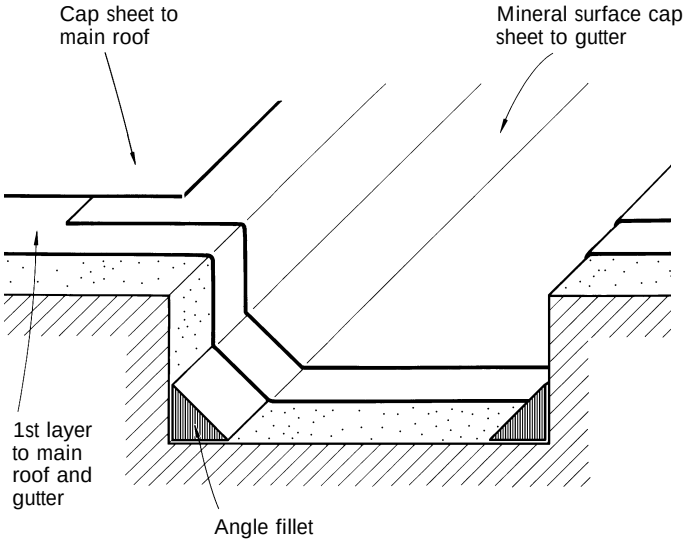
The cap sheet lining the gutter is normally mineral surfaced roofing, but where the main roof is surfaced with stone chippings a broad width gutter may also be surfaced with chippings.

The roofing in the sole of the gutter will follow the normal specification for flat areas, including partial bonding using BS 747 type 3G roofing as necessary. The sides of the gutter will always be fully bonded and are therefore more vulnerable to blistering if the insulation is one which would normally require a partial bond. To reduce the amount of blistering, the insulation for the vertical section is often changed to a material which is suitable for full bonding, such as wood fibreboard or cork.

When the insulation at the edge of the gutter is likely to be damaged by maintenance traffic, a hard nosing of timber or similar should be included to form a rigid stop for the insulation.

Mineral surfaced roofing normally has a 50mm margin or selvedge at the side of roll, with the mineral granules replaced by a sand finish to give the best contact surface for bonding side laps. It is desirable to start the mineral surfaced roofing at the outlet points so that the lap is in the direction of the flow of water.

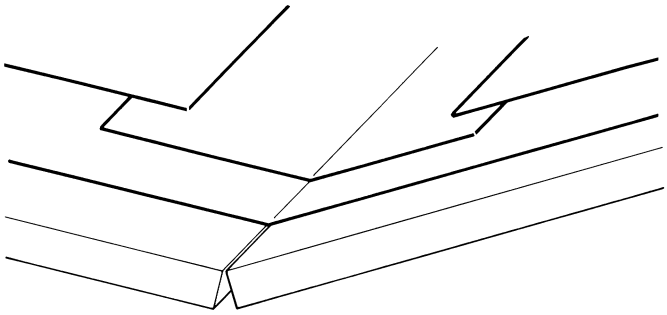
However, if the main area of the roof is formed from mineral surfaced roofing, it is essential that the



gutters are fully lined before the mineral surfaced cap sheet is applied to the adjacent main roof area, so that the main area cap sheet overlaps the gutter cap sheet in the direction of flow.

VALLEY GUTTERS

Valley gutters may be formed with a separate lining in much the same way as a box gutter, or by the continuation of the roofing from one slope through the valley and up the other slope for a short distance. This will then be overlapped by the main area roofing applied separately to the second slope.



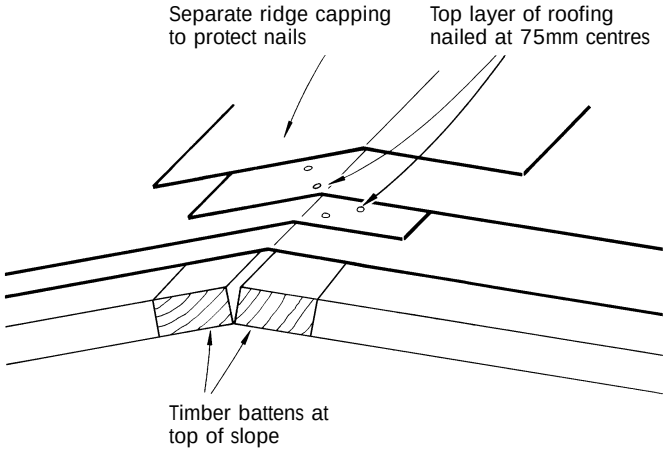
Valley formed with separate lining

The intersection of the valley results in a straight line joint of insulation, which is likely to show up differential movement between the two roof slopes, and the valley may be dead level between outlets. Crickets from cut-to-shape insulation may be added to improve drainage.

RIDGES

At a ridge the layers of roofing will be taken over on to each side, and a separate ridge cap formed as a final operation.

If the slope of the roof is such that nailing of the roofing is required to prevent slippage, the timber battens should be fixed to the deck and the insulation butted up to them. The roofing is then close nailed at 75mm centres in two lines, with the ridge cap protecting the heads of the nails.



RAINWATER OUTLETS

A choice of outlet with matching grating can be made from a wide range of proprietary cast iron, aluminium and plastic products, including outlets for syphonic drainage systems. All outlets for built-up roofing should have a wide bonding flange designed for the purpose. Some outlets include an angled or recessed position for felt to be turned into, and a clamping ring to retain the felt.

In all cases great care is necessary with the application of the felt to ensure a satisfactory bond. The flange should be primed and dried as necessary, and the built-up roofing made good.

In any event the material used for making good together with the thickness of the outlet flange will cause a raised surround to the outlet. This will inevitably hold water back, but it is better to accept this rather than put waterproofing integrity at risk by reducing the thickness of felt at the outlet.

The outlet may be set into a recess by cutting away the insulation and replacing it with a reduced thickness plywood or timber pad. This will compensate for the thickness of the outlet flange, but the material making good between outlet and main area will still cause an increased thickness around the recess.

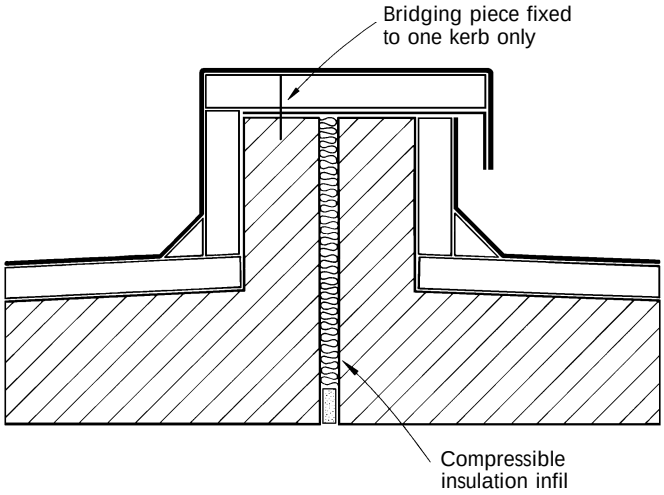
Outlets should be firmly fixed to the roof deck before making good with felt, but installed with a sliding fit into any downpipes with a straight vertical drop in order to allow for the thermal expansion and contraction of the downpipe.

There is still occasional use of straightforward drop outlets made of lead or sheet aluminium. They are fitted with wire cage gratings. Normal procedures apply. The flange can be 100mm, or preferably 150mm if there is room. This gives a first class bonding surface even if these outlets are crude by comparison with proprietary outlets.

EXPANSION JOINTS

Expansion joints in the waterproofing are only required where an expansion joint is allowed in the roof structure. Twin kerb expansion joints are always recommended.

The formation of loops or folds in the roofing will not provide a satisfactory allowance for movement as the majority of roofings, even high performance, should not be subjected to flexural movement.



A bridging piece fixed only to one kerb allows for differential movement between the kerbs. Insulation taken up and over the kerb will prevent a cold spot. Compressible insulation material may be placed within the gap to reduce draughts and further reduce the incidence of cold spots.

The ends of expansion joints at an open eaves detail should have boxed ends which make full allowance for the anticipated movement. At the ends of expansion joints against a higher level abutment, the joint should be taken up the vertical upstand without change of detail, and careful design may be necessary for provision of counter flashings.

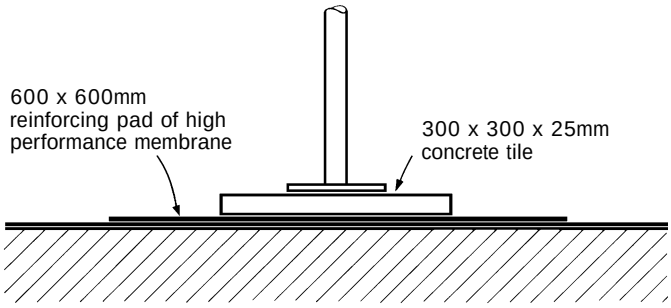
Proprietary expansion joints are available which are generally successful, and special units and intersections are available to simplify the detailing. Expansion joints which are designed to take up movement by the flexure of elastomeric strips are draught free and are easier to form into a satisfactory joint at the ends and at intersections. These joints are usually set on kerbs to keep them out of water.

All expansion joints should be formed above the roof level and will prevent drainage across them. The roof drainage system must be designed to take into account the position of any expansion joints and if necessary outlets should be provided adjacent to the expansion joints.

ROOF TOP ADDITIONS

BUILDING SERVICES

Services can be taken across the roof and supported by the roof if the compression strength of the insulation is sufficient. The load should be applied through pads which are removable for inspection and repair of the membrane. 300mm x 300mm x 25mm thick concrete tiles form a suitable pad. Most high performance roofings will accept loads in the order of 50kg transmitted through the pad, provided the deck and insulation can also accept the load without distortion or overloading.



Ducting or pipework should be kept at least 300mm above the surface of the roof. This allows the formation of satisfactory collars and flashings and gives room beneath the horizontal runs for repairs or re-roofing.

If the provision of services across a roof concentrates traffic into local areas, extra protective surfacing will be required to accept the extra traffic in that area.

Handrail standards should be attached to the structural frame and should preferably be set on kerbs. The waterproofing is made good as described for cold pipes.

TANKS AND HOUSINGS

Tanks, housings, condensers, ventilation units and similar items of roof top equipment should be installed on separate structural kerbs. It may be that a waterproofing is necessary under the tanks or ventilation units as a precaution against overflow or leakage of the casings or housings, but this should be separated from the waterproofing operation on the main roof areas. If this is not possible, there should be at least 900mm clearance between the underside of the unit and the roof surface to allow inspection and repair of the membrane beneath.

CLEANING RAILS

Cleaning rails and tracks for wheeled window-cleaning rigs must be included in the early stages of design; supports should be set on structural stools which are in turn attached to the structural frame. The membrane will be turned up to form a skirting around the stools and covered by a metal flashing inserted between the rail and the stool. Bituminous flashings are not suited to the compression and lateral forces which are associated with the support and fixing of the rail. Metal flashings should allow access to the membrane for inspection and repair without removal of the rail. If the load is light and lateral forces negligible, wheel tracks can be provided as raised paved areas near to the edge of the roof but not forming part of the roof edge detail.

AERIALS AND SIGNS

Aerials and signs should be supported on pads or frames designed for the purpose and trades who erect them should be instructed not to make fixings through the roofing without prior discussion with a roofing contractor, who should agree a satisfactory detail and make good afterwards. Large signs attract substantial wind forces and should be fixed to stools or frames tied back to the structural frame, and with proper provision for making good where the waterproofing is penetrated.

LIGHTNING CONDUCTORS

Short runs of lightning conductors may be laid loose on the surface of the roof, but if secure fixings are required special flanged brackets should be set into the roof and made good by a roofer. Alternatively clips can be fixed to concrete pads resting on the roof to avoid penetrating the waterproofing.

Where bonded felt strips are used to restrain lightning conductors, care should be taken to ensure that the conductors are not bonded into position, but are free to move under the felt strips.