BRITISH STANDARD

BS 8217:2005

Reinforced bitumen membranes for roofing —

Code of practice

ICS 91.060.20

Confirmed
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Committee responsible for this British Standard

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Association of British Roofing Felt Manufacturers

Association of Building Component Manufacturers

Flat Roofing Alliance

National Federation of Roofing Contractors

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Foreword

This British Standard has been prepared by Subcommittee B/546/3, under the direction of Technical Committee B/546. It supersedes BS 8217:1994, which is now withdrawn.

Products covered by this standard are commonly referred to as "roofing felts", but the new European product standard (prEN 13707) will refer to them as "flexible bitumen sheets for roof waterproofing". The finalized title of this standard needs to be understood clearly by the UK construction industry, and will hence refer to "reinforced bitumen membranes for roofing".

BS 6229:2003 gives recommendations on the design of flat roofs combining various types of continuously supported roof covering, insulation materials and roof decks. This British Standard gives detailed recommendations for reinforced bitumen membrane roofing on roofs designed to conform to BS 6229:2003. Much of the information is equally relevant to reinforced bitumen membrane roofing on sloping roofs also covered by this code.

A flat roof typically comprises a ceiling, structural supports, roof deck, waterproof covering and surface protection, and incorporates insulation and drainage. It might support ancillary items such as engineering equipment, hand railing and lightning conductors.

It is recognized that this standard might not fully cover all types of reinforced bitumen membranes or application techniques.

For convenience, recommendations for methods of attachment and recommendations for reinforced bitumen membrane roofing of different grades are given in Annex A.

It has been assumed in drafting this British Standard that construction will be carried out by trained operatives, who have sufficient training and awareness to work safely on flat roofing projects, under the direction of qualified supervisors.

This British Standard calls for the use of substances and/or procedures that may be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Attention is drawn to all pertinent current Health and Safety Executive publications, including *Health and safety in roofing* [1], *Test for fragility* [2], *The management of health and safety in construction* [3]; and also to the *Building regulations* [4] published by The Stationery Office, and the *Roofing handbook* [5] published by the Flat Roofing Alliance.

The European Product Standard for waterproofing membranes (prEN 13707) is currently in preparation; when this is introduced, BS 747:2000 will be withdrawn. Therefore, a new standard (to be numbered BS 8747) is being drafted, in the form of a specification and selection guide, to assist the UK specifier to select the correct layers in a reinforced bitumen membrane system for maximum performance and longevity.

As a code of practice, this British Standard (BS 8217) takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 55, and a back cover.

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1 Scope

This British Standard gives recommendations for the selection of reinforced bitumen membranes, their combination to form reinforced bitumen membrane roofing, and their application to flat and sloping roofs.

It also gives recommendations for mechanically fastened single-layer reinforced bitumen membranes, torch-applied bitumen membranes, and self-adhesive reinforced bitumen membranes for roofing.

The recommendations given for the design, construction and maintenance of new roofs are also applicable to the overlay of existing roofs, subject to confirmation of the suitability of the existing construction.

This code of practice does not address or apply to roofs used for special purposes such as car park areas.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 476-3:2004, *Fire tests on building materials and structures — Part 3: Classification and method of test for external fire exposure to roofs.*

BS 747:2000, *Reinforced bitumen sheets for roofing — Specification.*

BS 1202-1, *Specification for nails — Part 1: Steel nails.*

BS 2000-72, *Methods of test for petroleum and its products — Part 72: Determination of viscosity of cutback bitumen.*

BS 3690-2, *Bitumens for building and civil engineering — Part 2: Specification for bitumens for industrial purposes.*

BS 3927, *Specification for rigid phenolic foam (PF) for thermal insulation in the form of slabs and profiled sections.*

BS 3958-5, *Thermal insulation materials — Part 5: Specification for bonded man-made mineral fibre slabs.*

BS 4841-3, *Rigid polyurethane (PUR) and polyisocyanurate (PIR) foam for building applications — Part 3: Specification for two types of laminated board (roofboards) with auto-adhesively bonded reinforcing facings for use as roofboard thermal insulation for built-up roofs.*

BS 5250, *Code of practice for control of condensation in buildings.*

BS 5268-2, *Structural use of timber — Part 2: Code of practice for permissible stress design, materials and workmanship.*

BS 5268-5, *Structural use of timber — Part 5: Code of practice for the preservative treatment of structural timber.*

BS 5950-6, *Structural use of steelwork in building — Part 6: Code of practice for design of light gauge profiled steel sheeting.*

BS 6100-1.3.2:1989, *Glossary of building and civil engineering terms — Part 1.3.2: General and miscellaneous — Parts of construction works — Roofs and roofing.*

BS 6229:2003, *Flat roofs with continuously supported coverings — Code of practice.*

BS 6399-1, *Loading for buildings — Part 1: Code of practice for dead and imposed loads.*

BS 6399-2, *Loading for buildings — Part 2: Code of practice for wind loads.*

BS 6399-3, *Loading for buildings — Part 3: Code of practice for imposed roof loads.*

BS 7263-1, *Precast concrete flags, kerbs, channels, edgings and quadrants — Part 1: Precast, unreinforced concrete paving flags and complementary fittings — Requirements and test methods.*

BS 8103-3, *Structural design of low-rise buildings — Part 3: Code of practice for timber floors and roofs for housing.*

BS EN 300:1997, *Oriented strand boards (OSB) — Definitions, classification and specifications.*

BS EN 485-2:1995, *Aluminium and aluminium alloys — Sheet strip and plate — Part 2: Mechanical properties.*

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BS EN 515, *Aluminium and aluminium alloys — Wrought products — Temper designations.*

BS EN 622-4, *Fibreboards — Specifications — Part 4: Requirements for softboards.*

BS EN 636:2003, *Plywood — Specifications.*

BS EN 1426:2000/BS 2000-49:2000, *Methods of tests for petroleum and its products — Part 49: Bitumen and bituminous binders — Determination of needle penetration.*

BS EN 1427:2000/BS 2000-58:2000, *Methods of tests for petroleum and its products — Part 58: Bitumen and bituminous binders — Determination of softening point — Ring and ball method.*

BS EN 10147:2000, *Continuously hot-dip zinc coated structural steels strip and sheet — Technical delivery conditions.*

BS EN 12056-3, *Gravity drainage systems inside buildings — Roof drainage, layout and calculation.*

BS EN 12591, *Bitumen and bituminous binders — Specifications for paving grade bitumens.*

BS EN 13162, *Thermal insulation products for buildings — Factory made mineral wool (MW) products — Specification.*

BS EN 13163, *Thermal insulation products for buildings — Factory made products of expanded polystyrene — Specification.*

BS EN 13164, *Thermal insulation products for buildings — Factory made products of extruded polystyrene foam (XPS) — Specification.*

BS EN 13165, *Thermal insulation products for buildings — Factory made rigid polyurethane foam (PUR) products — Specification.*

BS EN 13166, *Thermal insulation products for buildings — Factory made products of phenolic foam (PF) — Specification.*

BS EN 13167, *Thermal insulation products for buildings — Factory made cellular glass (CG) products — Specification.*

BS EN 13168, *Thermal insulation products for buildings — Factory made wood wool (WW) products — Specification.*

BS EN 13169, *Thermal insulation products for buildings — Factory made products of expanded perlite (EPB) — Specification.*

BS EN 13170, *Thermal insulation products for buildings — Factory made products of compressed cork (ICB) — Specification.*

DD ENV 12872, *Wood-based panels — Guidance on the use of load-bearing boards in floors, walls and roofs.*

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions given in BS 6100-1.3.2:1989 and the following apply.

3.1
built-up reinforced bitumen membrane
two or more layers of reinforced bitumen membrane, bonded together with sealed joints to form a continuous waterproof covering; this also includes specifically designed bituminous single-layer systems with sealed joints, forming a continuous waterproof covering, and installed according to the manufacturer's instructions

3.2
base layer
first layer
layer of reinforced bitumen membrane which is laid first

3.3
intermediate layer
layer of reinforced bitumen membrane that is applied between the base/first layer and the top layer or capsheet

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3.4
top layer
uppermost layer of reinforced bitumen membrane that requires the application of surface protection

3.5
capsheet
uppermost layer of reinforced bitumen membrane that incorporates a protective finish

3.6
bonding bitumen
oxidized bitumen or other suitable bitumen compound melted and used hot

3.7
gritting solution
bitumen compound, formulated to bond a layer of mineral chippings to the surface of reinforced bitumen membrane roofing

3.8
full bonding
use of a continuous coat of bonding to adhere a layer of reinforced bitumen membrane roofing

3.9
partial bonding
use of a controlled and regular quantity of bonding, so as to provide adhesion over a proportion of the total area of the substrate

3.10
substrate
surface or layer upon which reinforced bitumen membrane roofing is laid

3.11
roof deck
part of the roof construction which supports the waterproofing system, including as appropriate the vapour control layer and insulation

3.12
warm deck roof
warm roof
roof in which the principal thermal insulation is placed above the roof deck and a vapour control layer, and immediately below the roof waterproofing

3.13
inverted roof
inverted warm deck roof
upside-down roof
protected membrane roof
roof in which the principal thermal insulation is placed above the waterproof covering

3.14
cold deck roof
cold roof
roof in which the principal thermal insulation is at or immediately above the ceiling

NOTE In heated buildings there is a need for any void between deck and insulation to be well ventilated.

3.15
access roof
roof used to provide access to plant or equipment

3.16
terrace roof
flat roof for use as an amenity area

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3.17
vapour control layer
VCL
construction material that substantially reduces the transfer of water vapour through the roof

NOTE 1 From BS 6229:2003.

NOTE 2 The performance of a VCL is dependent upon the material, workmanship and buildability.

NOTE 3 The VCL is usually a membrane.

3.18
cricket
tapered insulation wedge, usually thin, designed to promote flow along a parapet edge or a flat gutter line, or around obstacles such as a rooflight kerb, to reduce or prevent standing water (ponding)

NOTE The term "cricket" is usually used in the plural.

4 Exchange of information

For each project, there should be a full exchange of information amongst all involved with the roofing, including all pertinent safety considerations and risks. A detailed specification should be prepared, together with general arrangement and detail drawings, for each area of roof.

The various parties should agree:

a) levels and dimensions of the areas to be roofed;

b) construction, including the deck, its condition, and any preparation required;

c) falls and drainage arrangements;

d) any vapour control layers;

e) any penetrations, fixtures, or attachments;

f) the composition of the reinforced bitumen membrane roofing, the method of attachment to the roof deck and the type of surface protection;

g) provision for access to the works;

h) provision for temporary storage of materials and location of plant including limitations of roof loading;

i) provision of scaffolding, hoists, ladders and safety equipment, temporary lighting, power, water and temporary protection including temporary shoring and walkways;

j) facilities for removal of rubbish and surplus material;

k) requirements for supervision, inspection, and testing; and

l) requirements for future maintenance.

5 Materials

5.1 Roof decks

5.1.1 *Introduction*

Reinforced bitumen membranes should only be applied over a continuous substrate which provides full support.

NOTE 1 The type of substrate will critically influence the choice of reinforced bitumen membrane and its method of attachment (Clause **7**).

NOTE 2 Recommendations for the installation and preparation of roof decks of the materials listed here to receive reinforced bitumen membrane roofing are given in **5.1.2** to **5.1.9**.

NOTE 3 Decks are frequently overlaid with cementitious screeds, and with rigid or semi-rigid board materials. The preparation of cementitious screeds to receive reinforced bitumen membrane roofing is described in **5.1.2**. Recommendations for the installation of rigid insulation board materials are given in **5.3**.

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Materials used to form the roof deck in flat roofs should be those listed in BS 6229:2003, i.e.:

a) reinforced concrete;

b) wood wool slabs;

c) profiled metal decking (steel or aluminium);

d) timber boarding;

e) plywood;

f) composites;

g) oriented strand board;

h) wood particle board.

These materials may also be used to form the substrate in pitched roofs intended to be covered by reinforced bitumen membrane roofing.

5.1.2 *Reinforced concrete*

For the purposes of this British Standard, concrete decks may be taken to include both in situ and pre-cast concrete, and all flush-finish cementitious screeds.

Where a roof slab of reinforced concrete is designed as the deck which will directly support reinforced bitumen membrane roofing, it is preferable to lay the slab to provide adequate drainage falls as recommended in BS 6229:2003. The surface of the concrete should be finished with a wood float to provide a suitably smooth surface free from ridges and hollows. Provision should be made for drying out the slab. A concrete surface which is not adequately smooth, or does not provide even drainage falls, should be screeded to correct these points.

In order to ensure a good degree of bonding of the first layer of the roofing system, new concrete or screeded decks should be given adequate time to dry out, prior to installing the reinforced bitumen membrane roofing. At the very least, all surfaces should be touch dry, and not be subject to returning moisture once any drying (e.g. torching) has ceased.

In most warm or inverted roofs, the deck will continue to dry out downwards for a period. However, where permanent impermeable shuttering is incorporated, full upward drying is particularly important, as the shuttering will not allow the deck to dry downwards. Drilled holes or perforations will only allow a part of the construction water contained to drain, hence it is imperative that the deck is dried out from above before laying any reinforced bitumen membrane roofing.

Pre-cast reinforced concrete units and composite constructions incorporating hollow tiles, pre-cast beams and planks, etc. should be overlaid with a suitable cement-sand topping to provide a surface as previously described.

Where a reinforced concrete roof slab is overlaid with a screed, to level or to provide falls, such screed should be in accordance with BS 6229:2003. The surface should be finished with a wood float to provide an even surface, free from ridges and hollows.

Screeds should be allowed to dry out as previously described, before laying any reinforced bitumen membrane roofing.

Aerated autoclaved concrete (AAC or "Siporex") can have the appearance of reinforced or pre-cast concrete units. However, this material is fragile, and suitable precautions should be taken. Attention is drawn to Health and Safety Executive publication, *Health and safety in roofing* [1].

5.1.3 *Wood wool slabs*

Roof decks of wood wool slabs should be formed from slabs conforming to BS EN 13168, not less than 50 mm thick, with a mesh reinforcement and with a pre-screeded or pre-membraned top surface, and channel-reinforced where appropriate.

Slabs should be fixed to the structure in accordance with the manufacturer's instructions. All slab joints should be covered with reinforced bitumen tape, minimum 100 mm wide, located carefully with cold or hot applied bitumen, to prevent the penetration of hot bonding bitumen.

Wood wool slabs are designated as "fragile" in the UK, and suitable precautions should be taken. Attention is drawn to Health and Safety Executive publication, *Health and safety in roofing* [1].

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5.1.4 *Profiled metal decking*

A profiled metal deck does not provide a continuous supporting upper surface for the direct application of reinforced bitumen membranes, therefore the crowns should comprise approximately 50 % of the total area.

Profiled metal roof decking should be manufactured either in galvanized steel to BS EN 10147:2000, or in aluminium to BS EN 485-2:1995. If required, both specifications of metal can be supplied with a coloured painted underside.

The profile type and size should also be as stated in the manufacturer's load/span tables, and due consideration should be given to BS 6399-2 wind loading code, and all possible construction loadings.

Fixing to the structure should also be in accordance with BS 6399-2 and the manufacturer's instructions. All use of profiled steel sheeting should comply with BS 5950-6.

The profiled metal deck should be selected to avoid deformation of the sheet in those areas subjected to point loads imposed by foot traffic or storage of materials.

5.1.5 *Timber boarding*

Roof decks of timber boarding should be designed in accordance with BS 6229:2003 and BS 5268-2. The timber should be naturally durable or pre-treated against infestation by wood-boring insects and fungal decay as recommended in BS 5268-5. Any method of pre-treatment specified should be compatible with the use of bitumen-based products over prolonged periods.

Boarding should be not less than 19 mm nominal thickness, planed and closely clamped together, with tongued and grooved joints or closely butted, and secured by ring-shank nailing or screwing, at a rate of two per board width, at both ends and at every intermediate support. Nail heads should not protrude.

5.1.6 *Plywood*

Plywood roof decks should be designed in accordance with BS 6229:2003 and BS 8103-3, with a minimum thickness of 15 mm for joist spacings up to 450 mm, and 18 mm for spacings up to 600 mm.

Timber and timber products (including plywood) for structural use should comply with BS 5268-2.

The plywood should conform to the relevant requirements of BS EN 636:2003, Clause **7** regarding use in humid conditions, and Clause **8** regarding exterior use. Materials suitable for flat roofing would be marked "BS EN 636-2" or "BS EN 636-3".

It is permissible for the plywood to be preservative treated, but any such treatment should be compatible with bitumen-based products over prolonged periods.

Plywood for roof decks is normally square-edged. Longitudinal joints should occur on the centre line of supporting joists. Cross-joints should be staggered and will require additional support, e.g. by noggins.

Panels supported on a timber structure should be fixed using corrosion-resistant ring shank nails or screws at 150 mm centres around the perimeters of the panels, and 300 mm centres along the supports, in accordance with DD ENV 12872.

A joint gap of one millimetre per metre of the panel size should be allowed at all edges, including perimeters, i.e. a 2.4 m board should have a 2.4 mm gap between adjacent boards.

5.1.7 *Composites*

Proprietary composite decking systems are available, comprising a plywood upper layer, a rigid urethane foam (or similar insulation) core, and commonly incorporating a lower face of reinforced aluminium foil.

These boards should not be used in areas of high humidity, such as bathrooms or kitchens.

Installation should usually be as with plywood decking (**5.1.6**), but the additional thickness will entail much longer fixings. Panels should be fixed with a gap of approximately one millimetre per metre of the panel size at all edges, including perimeters. Boards should be protected from the weather and should remain dry.

The boards should be secured with corrosion-resistant ring shank nails or screws at spacings defined by the panel manufacturers, and all edges of panels should be fully supported on joists and noggins.

As the foam cores have relatively low compressive strength, care should be taken to ensure that the joists and noggins all have adequate bearing surfaces, and that the panels are not subjected to excessive loadings.

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If included, the foil facing is normally intended to form and perform as a vapour control layer. To be effective in such cases, the foils on adjacent panels should be connected by laying a sealant along all joists and other bearing timbers just before the panel is placed into position and fixed.

5.1.8 *Oriented strand board*

Oriented strand board (OSB) should be type OSB/3 or OSB/4, conforming to BS EN 300:1997. Boards should be protected from rain/water and remain dry.

OSB roof decks should be designed in accordance with BS 6229:2003 and BS 8103-3, with a minimum thickness of 15 mm for joist spacings up to 450 mm, and 18 mm for spacings up to 600 mm.

Oriented strand board can be square-edged or tongued and grooved. All square edges should be supported on the joists, or on additional noggins, using corrosion-resistant ring shank nails or screws. The boards should be fixed at 150 mm centres around the perimeters of the panels, and 300 mm centres along the supports, in accordance with DD ENV 12872.

The nail length should be at least 2.5 times the board thickness. Boards should be fixed with a gap of two millimetres per metre of the panel size at all edges, including perimeters.

5.1.9 *Wood particle board*

Decks of wood particle board ("chipboard") are referred to in BS 6229:2003.

However, their use under flexible reinforced bitumen membranes is no longer recommended.

5.2 Vapour control layers

5.2.1 *Introduction*

Membrane materials suitable for use as vapour control layers in a flat roof are listed in BS 6229:2003, but are summarized as:

a) flexible reinforced bitumen membrane, bonded and lapped;

b) metal-cored flexible reinforced bitumen membrane, bonded and lapped;

c) polyethylene sheet with sealed laps;

d) polyethylene sheet with metal core and sealed laps;

e) one coat 12 mm thick of mastic asphalt on glass fibre tissue.

In the majority of reinforced bitumen membrane roofs, the VCL will comprise a) or b).

The choice of VCL will depend on the degree of moisture vapour pressure produced, the specified substrate, and the need for a robust temporary waterproofing layer.

5.2.2 *Fully supporting roof decks*

On a fully supporting roof deck such as concrete, a single layer of reinforced bitumen membrane will provide an adequate level of vapour control for normal conditions.

On a timber-boarded deck, the first layer of reinforced bitumen membrane should be attached by full nailing as described in **8.15.1**. See also **7.3.4**.

NOTE A self-adhesive reinforced bitumen VCL could be used on a timber-boarded deck as described in **7.3.2.1**.

For high levels of vapour pressure, a foil-cored reinforced bitumen membrane or a multi-layer vapour control system should be used. See also **7.3.2.3**.

5.2.3 *Profiled metal roof decks*

On profiled metal decking, a limited level of vapour control may be achieved by sealing and stitching all side and end laps.

In circumstances where improved vapour control is required, a vapour control layer (VCL) may be formed of reinforced bitumen membrane, with a polyester reinforcement for robustness when bridging troughs and to resist damage.

The VCL should be bonded to the crowns of the deck, or clamped beneath mechanically fastened insulation boards. In both cases, all laps should first be sealed with bitumen or a suitable cold adhesive.

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Where higher degrees of vapour resistance are necessary, either a two-layer polyester-reinforced vapour control system should be installed, with the second layer incorporating a foil core, or the foil-cored vapour control layer should be fully supported by a continuous deck surface. This could be provided by mechanically fixing a suitable overlay board to the profiled deck.

5.3 Thermal insulation materials

5.3.1 *Introduction*

Insulation materials suitable for use in flat roofs are listed in BS 6229:2003. The type of thermal insulation material chosen will influence the choice of reinforced bitumen membrane, its method of attachment, and the choice of vapour control layer.

Recommendations for materials and installation for various types of rigid insulation board for use in warm roofs to be covered with reinforced bitumen membranes are given in **5.3.2** to **5.3.12**.

The various types and uses are shown in Table 1.

Table 1 — Types and uses of thermal insulation

Thermal insulation material	Abbreviation (if used)	Applications	
		Warm roof	Inverted roof
Cellular foamed glass (slabs or boards)	CG	Yes	No
Compressed cork		Yes	No
Expanded moulded polystyrene ("beadboard")	EPS	Yes	No
Extruded expanded polystyrene	XPS	No	Yes
Composite tiles (e.g. XPS, with an integral tile surface or topping)		No	Yes
Fibreboard, bitumen-impregnated (wood fibre softboard: normally used in conjunction with expanded polystyrene)	FB	Yes	No
Perlite		Yes	No
Polyurethane foam (rigid urethane foam)	PU, PUR, or RUF	Yes	No
Polyisocyanurate foam (rigid urethane foam)	PI, PIR, or RUF	Yes	No
Phenolic foam	PF	Yes	No
Rigid glass or mineral fibre boards		Yes	No
Composite boards or decks (e.g. cork + RUF, plywood + RUF, perlite + RUF)		Yes	No
Glass or mineral insulation quilts[a]		No	No

[a] These are not suitable for warm or inverted roofs, and are only used in cold roofs; see **6.8**.

The type, thickness, shape (plain/uniform or tapered board), and facing materials of insulating materials should be clearly specified, together with the pattern of laying and the method of fixing/attachment to the deck. In all cases, the insulation product should be suitable for the proposed application, and installed in accordance with the manufacturer's instructions.

NOTE 1 Some types of insulation are produced with specialist facings for use with either torch-applied or self-adhesive membrane systems.

NOTE 2 Some types of insulation are available with rebated edges to reduce cold bridging at board joints.

NOTE 3 The thickness of some products required to achieve mandatory thermal transmittance might be such that their use is impractical. Boards of such low thermal performance are generally used in refurbishment as a recovery board, or as an overlay in a composite product in order to achieve different performance characteristics.

NOTE 4 The standards referenced for insulation materials do not include density; the figures referred to in **5.3.2** to **5.3.12** are typical manufacturers' quoted values for roofing.

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5.3.2 *Cellular foamed glass (CG)*

Cellular foamed glass insulation slabs and boards should conform to BS EN 13167.

They should also have a density between 120 kg/m^3 and 130 kg/m^3, except where regular foot or vehicular traffic is anticipated, when higher density slabs (up to approximately 200 kg/m^3) should be specified.

The slab form should be fully bonded (with all joints filled), and completely encapsulated in hot or cold bitumen bonding compound, specifically to the manufacturer's instructions. Cellular foamed glass insulation boards are also available, designed to be used only with torch-applied reinforced bitumen membrane roofing. The boards are faced on their upper face with a bitumen coat and a sacrificial film, and on their lower face with a glass tissue. These can be bedded in hot or cold bonding compound, or onto strips of cold adhesive.

In all cases, the first layer of reinforced bitumen membrane roofing should be fully bonded to the cellular glass. Subsequent layers should also be fully bonded.

Cellular foamed glass insulation slabs can be susceptible to mechanical damage during installation.

5.3.3 *Compressed cork*

Compressed cork boards should conform to BS EN 13170. The boards should consist of pure granulated cork, compressed into slab form, steam baked and held together by natural cork gum.

Generally, roofing cork should have a density of 125 kg/m^3, but the minimum density should be 110 kg/m^3 because lower densities are friable and easily damaged. For very thin sections or crickets, higher densities should be specified.

Cork is suitable for the direct application of hot bitumen: boards may be fully bonded in hot bonding compound and/or be mechanically fastened. The first layer of reinforced bitumen membrane roofing should be fully bonded to the top surface of cork insulation boards.

5.3.4 *Expanded moulded polystyrene (EPS)*

Expanded moulded polystyrene boards (or "beadboards") should meet or exceed EPS70 or EPS100 of BS EN 13163.

This material is extremely heat-sensitive. Expanded polystyrene boards should be mechanically fastened or bonded in cold or hot bonding compound. The latter should be allowed to cool to a tacky consistency after spreading and before application of the boards.

Expanded polystyrene boards should be pre-surfaced with a reinforced bitumen membrane, or be overlaid with a layer of bitumen-impregnated fibreboard not less than 12 mm thick, or a cork board or other suitable insulation, to provide protection against the heat of the bonding compound. Joints in the boards should be taped to prevent bitumen seepage and damage.

The first layer of reinforced bitumen membrane roofing should then be fully bonded to the reinforced bitumen membrane surface or to the overlay board.

5.3.5 *Extruded expanded polystyrene (XPS)*

Extruded expanded polystyrene (XPS) should conform to BS EN 13164.

Extruded polystyrene boards are suitable for inverted roof constructions, where they should be laid loose and ballasted against wind uplift or flotation in accordance with the manufacturer's instructions.

See also BRE Digest 295 [6].

5.3.6 *Wood fibreboard (softboard) — Bitumen impregnated*

It is imperative that wood fibreboard used in reinforced bitumen membrane roofs is bitumen-impregnated, conforming to BS EN 622-4. The density should not exceed 400 kg/m^3.

The dimensional stability of this board makes it useful as an overlay to other insulants more susceptible to thermal movement, such as expanded polystyrene (EPS). Wood fibreboard is suitable for direct application of hot bitumen, and should be fully bonded in hot bitumen and/or mechanically fastened. The first layer of reinforced bitumen membrane roofing should be fully bonded to the top surface of fibreboard, unless a fully mechanically fixed system is being considered.

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5.3.7 *Perlite boards (EPB)*

Perlite insulation boards should conform to BS EN 13169.

The typical density for boards between 20 mm and 120 mm is 150 kg/m^3. Thinner boards, used as an overlay or for improved trafficability, should have a density of 200 kg/m^3 to 220 kg/m^3.

Some earlier perlite boards were vulnerable to delamination. However, higher laminar-strength boards are now available, and these should be specified.

Depending upon the design wind pressure, special precautions might still be necessary in exposed areas, thus consideration should be given to the need for additional mechanical fixing of the bitumen membrane roofing.

Perlite is suitable for the direct application of hot bitumen and boards should be fully bonded in hot bonding compound and/or be mechanically fastened.

The first layer of reinforced bitumen membrane roofing should be fully bonded to the top surface of perlite insulation, unless a fully mechanically fixed system is being considered.

Some boards are also suitable for torch-applied membranes.

5.3.8 *Rigid urethane foam (RUF), including polyurethane (PU or PUR) and polyisocyanurate (PI or PIR)*

Insulation boards of rigid urethane foam should conform to BS 4841-3 and BS EN 13165.

The typical density should be between 28 kg/m^3 and 36 kg/m^3.

PIR roofboards are similar in many respects to PUR boards, but generally have better fire retardant properties.

Boards should be fully bonded in hot or cold bonding compound and/or be mechanically fastened.

The first layer of reinforced bitumen membrane roofing should be partially bonded, by first laying over a bitumen membrane conforming to BS 747:2000, type 3G for pour-and-roll applications, or a proprietary perforated membrane for torch-on uses. Either of these layers should be applied loose-laid onto the top surface of the boards. Some manufacturers produce proprietary systems which do not require a perforated layer.

5.3.9 *Phenolic foam (PF)*

Phenolic foam insulation boards should conform to BS 3927 and BS EN 13166.

The typical density should be between 33 kg/m^3 and 40 kg/m^3.

Boards should be fully bonded in hot or cold bonding compound and/or be mechanically fastened.

The first layer of reinforced bitumen membrane roofing should be partially bonded, by first laying over a bitumen membrane conforming to BS 747:2000, type 3G for pour-and-roll applications, or a proprietary partial bonding membrane for torch-on uses. This layer should be applied loose-laid onto the top surface of the boards.

5.3.10 *Rigid glass/mineral fibre insulation boards*

Insulation boards of rigid glass or mineral fibre should conform to BS 3958-5 and BS EN 13162. The nominal average density should be between 135 kg/m^3 and 200 kg/m^3.

NOTE Boards for roofing applications are commonly manufactured with a treatment or facings to provide an improved surface, either for the application of hot bonding compound or for the torching-on of suitable membranes, and these generally produce a high laminar strength bond to the board. Other, low-strength boards would not be suitable.

The boards may be fully bonded in hot or cold bonding compound and/or mechanically fastened.

Depending upon the design wind pressure, it may be necessary to take special precautions in exposed areas against delamination of low laminar strength boards.

The first layer of reinforced bitumen membrane roofing should be fully bonded to the top surface of rigid glass/mineral fibre boards, unless a fully mechanically fixed system is being considered.

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5.3.11 *Composite insulations*

The composite insulation boards/systems available usually comprise a rigid urethane foam (RUF), expanded polystyrene (EPS), or similar insulation as the core, with a second insulant or material bonded to the upper face. This could be cork, perlite, or even a plywood upper layer (see **5.1.7**).

Such composites combine a board of efficient insulation value, with the resilience and trafficability of cork or plywood, or the fire resistance of perlite.

The boards are normally suitable for full bonding in cold or hot bonding compound and/or for mechanical fastening (EPS boards need to be protected from the direct heat of molten bitumen; see **5.3.4**). Boards should be protected from the weather and should be kept dry.

The first membrane layer should be installed as appropriate for the uppermost insulation material.

5.3.12 *Glass or mineral fibre quilt — For cold roofs only*

Cold roofs are not recommended in this code. Insulation manufacturers should be contacted for their advice.

5.4 Flexible reinforced bitumen membranes for roofing

5.4.1 *General*

BS 747:2000 lists some of the flexible bitumen membranes suitable for use to form waterproof coverings on flat and pitched roofs when applied in accordance with this British Standard. The only high performance bitumen membranes currently covered by BS 747:2000 are polyester-reinforced bitumen membranes to classes 5B, 5U and 5E.

Other types of high performance bitumen membrane are available, including both oxidized bitumen and polymer-modified bitumen membranes, and may also be used. It should be established that they have been properly evaluated and found suitable for use on flat and sloping roofs. These include in particular torch-on bitumen membranes.

There are also reinforced bitumen membranes that are designed for cold application, either bedded into cold mastic, or as self-adhesive systems. All of these have advantages for particular circumstances. Therefore, specific reference should be made to manufacturer's advice and third-party certification for the use of these other types of reinforced bitumen membranes.

The types of bitumen membranes given in **5.4.2**, **5.4.3** and **5.4.4** for roofing are readily available.

5.4.2 *Oxidized reinforced bitumen membranes*

BS 747:2000 lists classes of reinforced bitumen membranes suitable for use to form waterproof coverings. Those for use in reinforced bitumen membrane roofing comprise glass fibre or polyester base carriers, coated with oxidized bitumen.

These products are designed only for pour-and-roll or cold application.

5.4.3 *Modified reinforced bitumen membranes — Elastomeric*

Elastomeric modified bitumen membranes are produced on glassfibre, polyester, and glass/polyester mixed base carriers. The carrier is saturated and/or coated with styrene butadiene styrene (SBS)-modified bitumen.

These products can be manufactured as suitable for application by pour and roll, by torching, by use of cold adhesive, as a self-adhesive material, or by mechanical fastening.

5.4.4 *Modified reinforced bitumen membranes — Plastomeric*

Plastomeric modified bitumen membranes are produced on glassfibre, polyester, and glass/polyester mixed base carriers. The carrier is saturated and/or coated with atactic polypropylene (APP)-modified bitumen.

These products can be manufactured as suitable for torching or cold adhesive applications.

They are not suitable for pour-and-roll or for mechanically fastened applications.

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5.5 Surface finishes

5.5.1 *General*

Reinforced bitumen membranes can be finished in a number of ways. The surface finish on a reinforced bitumen membrane roof performs a number of functions, such as improving fire resistance, reducing solar uptake and providing protection from traffic or puncture damage.

5.5.2 *Self-finished reinforced bitumen membranes (factory-applied protection)*

This can be in the form of mineral slates or inorganic granules, usually available in a variety of colours, or a thin metal foil; commonly aluminium, copper, or stainless steel.

5.5.3 *Paint finishes*

Proprietary paint systems are available to protect reinforced bitumen membranes from ultraviolet light and to give some measure of protection from solar gain. Paint should be compatible with bituminous materials, and should preferably be applied to a slate granular (mineral) surface in accordance with the manufacturer's instructions, because when applied to a sanded bitumen surface they have a reduced life. Painted surfaces should be maintained or re-coated at regular intervals to preserve their effectiveness and appearance.

5.5.4 *Stone aggregate (chippings)*

Certain stone aggregates can be used as a surface protection to a reinforced bitumen membrane roof. These include crushed limestone or white spar, and should be applied in a bitumen dressing compound (see **5.6.4**) or in bonding bitumen (see **5.6.3**).

The aggregate should be graded single-sized aggregate, 12.5 mm nominal size for flat roofing.

5.5.5 *Ballast*

Ballast for use on inverted or warm roofs should be clean, rounded aggregate graded 40 mm to 20 mm, and as free as practicable from fines.

5.5.6 *Concrete paving slabs*

Concrete paving slabs for use as walkways or as paving on terrace decks, including inverted roofs, should conform to BS 7263-1. When supported only at their edges or corners, their suitability for this application should be confirmed by the manufacturers.

5.5.7 *Walkway tiles*

Several types of tiles to form walkways or terrace deck paving are available. These can be manufactured from semi-porous concrete, glass-reinforced polyester (GRP), dense or granular rubber, or fibre cement. They are normally bedded in a bonding compound or proprietary adhesive, and should be fixed in accordance with the manufacturer's recommendations.

5.5.8 *Other finishes*

Other decorative finishes (roof gardens, timber decking, trafficable surfaces, etc.) are also available.

Some of these can require specialist membranes or installation methods, thus the membrane manufacturer's or system designer's instructions should be followed.

5.6 Ancillary components

5.6.1 *General*

Reinforced bitumen membrane roofing requires the use of various ancillary materials and products, some of which are covered by British Standards. It should be established, by reference to manufacturer's information and test results, whether materials and products not covered by a British Standard will be suitable for use in reinforced bitumen membrane roofing.

The following items might be required, but this is not an exhaustive list.

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5.6.2 *Bitumen primer*

Bitumen primer should be bitumen cut back with volatile solvent; it should have the following characteristics when tested in accordance with BS 2000-72:

a) minimum volatile solvent content: 40 % by mass;
b) maximum viscosity (STV at 25 °C, 4 mm orifice): 10 s.

Allowance should be made for drying time, prior to commencing torch-on application.

Cold-applied or self-adhesive types of membrane might require specialist modified primers (also referred to as "conditioners"); advice should be sought from the relevant manufacturer.

5.6.3 *Bonding bitumen*

5.6.3.1 *General*

In forming reinforced bitumen membrane roofing, the bonding compound is essentially an adhesive and, to perform properly, it should be applied at the correct viscosity. Viscosity varies with temperature; grades with low softening-point temperature (see Table 2) flow more readily at lower temperature.

Attention is drawn to the recommendations regarding heating of bitumen given in **8.1**.

5.6.3.2 *Oxidized bonding bitumen*

Bonding bitumen should consist of oxidized bitumen conforming to the requirements of BS 3690-2. Bonding bitumen is available in grades, which are designated by numbers representing the softening point temperature and penetration when tested in accordance with BS EN 1426:2000 (formerly BS 2000-49) and BS EN 1427:2000 (formerly BS 2000-58).

Table 2 — Grades of bitumen used in reinforced bitumen membrane roofing

Common description grade	Softening point (ring and ball) °C	Penetration range at 25 °C mm
95/25	90 to 100	20 to 30
115/15	110 to 120	10 to 20
WARNING One other grade of bitumen, 105/35, is available for specialist uses. This grade should be used with caution, as its working temperature is quite close to its flashpoint. NOTE 1 The values listed are those of materials as delivered to site. NOTE 2 Heating of bitumen can result in small changes from the listed figures.		

5.6.3.3 *Elastomer-modified bonding bitumen*

Proprietary modified bitumen bonding compounds are available, and should be used in accordance with the manufacturer's recommendations.

Such products can require lower installation temperatures, hence it is strongly advised to use a thermostatically controlled bitumen boiler. See also **8.1**.

5.6.3.4 *Cold bonding bitumen compounds*

These can include emulsions, contact adhesives and mastics, and can be used for bonding insulation boards and/or reinforced bitumen membranes. In all cases, advice on their suitability, compatibility and application techniques should be obtained from the relevant manufacturer.

5.6.3.5 *Specialist adhesives*

Other adhesives (e.g. polyurethanes) are available for bonding insulation boards and/or reinforced bitumen membranes. These should be used in accordance with the manufacturer's instructions.

5.6.4 *Dressing compound*

Dressing compound should be hot or cold-applied bitumen solution conforming to BS EN 12591.

5.6.5 *Nails*

Nails for fixing reinforced bitumen membranes should be galvanized extra large round-headed clout nails, conforming to BS 1202-1.

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5.6.6 *Fasteners for mechanically fixed insulation and reinforced bitumen membranes*

Fasteners commonly comprise a shaft, in the form of a screw, or an expanding anchor or peel rivet, together with a disc-shaped washer or stress plate or collar.

Forces are usually transmitted to the fastener by the clamping action of the washer or stress plate.

To avoid cold bridging, some washers incorporate a plastic sleeve. Care should be taken to ensure the compatibility and, in particular, the corrosion resistance of the fixing with the waterproofing, insulation, and decking components.

5.6.7 *Perimeter trims*

Perimeter trims are available to various profiles. They should be manufactured from extruded aluminium conforming to BS EN 515, or glass reinforced plastic, installed in accordance with the manufacturer's instructions. Lengths up to three metres are generally available. Other proprietary systems are available.

Formers for use in welted drips should be cut from hardboard or six millimetre WBP plywood, primed, and nailed with the capsheet to the drip batten. The size will depend upon the project requirements.

5.6.8 *Triangular fillets*

Triangular fillets should be formed of cork, fibre board or other suitable insulation board, or treated timber. Common sizes are 50 mm × 50 mm and 75 mm × 75 mm.

For torched applications, low or non-combustible fillets (e.g. mineral fibre, perlite, cellular glass) should be used.

5.6.9 *Metal flashings*

For lead, Code 4 or 5 is usually required for flashing of details. Maximum lengths and girths should be established in accordance with Lead Sheet Association (LSA) recommendations.

Other metals (zinc, copper, aluminium, etc.) should be used in accordance with guidance from the relevant trade associations.

5.6.10 *Hard Edges*

At external perimeters, gutter edges, etc. the insulation should be protected from crushing under occasional traffic loads. If timber is used for this, it should be pressure-treated. The thickness should be reduced compared with the adjacent insulation boards, to avoid creating water checks and allow lapping of the waterproofing layers. The outer edge should be radiused or chamfered to facilitate installation of reinforced bitumen membranes without voids beneath.

It is imperative that the pressure treatment is compatible with the bitumen, and with the chosen insulation. Copper chrome arsenate (CCA) is not a suitable treatment.

Alternatives, e.g. once-bent 1.6 mm galvanized steel or purpose-made proprietary products, may also be used.

5.6.11 *Timber battens*

Support battens for sloping and vertical work should match the insulation thickness, and should be pressure treated, ensuring the treatment is compatible with the bitumen and the chosen insulation. CCA is not a suitable treatment. Drip battens should be similarly treated.

5.6.12 *Rainwater outlets*

Rainwater outlets are available in many materials and styles, for differing system and locations. For use with reinforced bitumen membranes, they should be compatible with bitumen, and able to tolerate the temperatures of molten bitumen (except with cold-bonded or self-adhesive products). Suitable materials include; cast metal, pressed metal, heavy-duty rubber/EPDM, or (for cold-bonded or self-adhesive products) heavy-duty plastics.

The outlet should have a broad flange to allow adequate bonding of the membranes.

The outlet assembly should be designed for the particular location, circumstances, and the roof construction chosen, i.e. warm, inverted or cold. The manufacturer of the selected roof outlet(s) should be consulted before any modification or change of use of such assemblies.

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Rainwater outlets are generally available to suit three types of location:

a) in the main field of an area, feeding vertically into the downpipe;

b) at a perimeter, feeding vertically into the downpipe (e.g. balcony outlet); and

c) at a perimeter, feeding horizontally into the downpipe or a chute (e.g. parapet outlet).

Balcony outlets often feed vertically, with an extra aperture in the grille to accept a downpipe from an upper level roof. Also, some specialist parapet outlets have a combined body shape which can be mounted either way to suit the designer's requirements.

Warm roof outlets are commonly formed in two linking sections, the lower being sealed to the vapour control layer and the downpipe. The upper part serves the main waterproofing, fits into and seals with the throat of the lower. The height between will depend upon the insulation thickness.

Cold roof outlets drain at a single waterproofing level, as do most outlets for inverted roofs. The latter require a deeper gravel guard extending above the height of the ballast layer.

For metal-based roof outlets, the outlet body should be painted with a suitable bitumen primer (**5.6.2**) prior to its installation, to aid adhesion of the waterproofing. The roof outlet assembly should have a waterproofing clamping collar (ring), so that the waterproofing membrane is mechanically clamped into the outlet and not reliant on the primer/adhesive/ membrane interface alone.

Refurbishment outlets are often fitted into the throat of existing outlets, to avoid disturbing the old system. These should be a close fit and reduce the throat diameter as little as possible, and should incorporate a form of sealing to the old down-pipe to prevent water damage in the instance of a pipe backing up due to a lower blockage.

Such outlets cannot achieve the same maximum drainage rates as the original units, due to their reduced diameter and a sharper entry to the throat. A localized sump should be retained (see **6.2**).

5.6.13 *Filter layers*

In an inverted roof, fines should be prevented from being washed between or under the insulation boards, where they could cause damage to the insulation or the waterproof membrane. This layer also increases the effective wind uplift resistance produced by the ballasting provided.

Therefore a filter layer, comprising a suitable rot-proof, vapour-permeable fabric mesh or non-woven geo-textile, should be loose laid over the insulation prior to installing the ballast.

5.6.14 *Lightning conductor and cable clips*

Mechanical fixings should not be used to retain lightning conductor tapes or cables on the roof surface.

Proprietary clips are available to fasten conductor tapes to the roof surface securely, without penetrating the waterproofing.

6 General design considerations

6.1 General

The design of flat roofs intended to be covered by reinforced bitumen membrane roofing should conform to the recommendations of BS 6229:2003, and to **6.2** to **6.13**, with regard to:

a) falls and drainage (**6.2**);

b) dead and imposed loads (**6.3**);

c) design wind loads (**6.4**);

d) structural strength, stiffness and deflection limits (**6.5**);

e) movement (**6.6**);

f) protection against trapped moisture (**6.7**);

g) thermal design, choice and location of insulating materials (**6.8**);

h) control of condensation (**6.9**);

i) sound insulation (**6.10**);

j) fire precautions (**6.11**);

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k) surface protection (**6.12**);

l) roof plant and equipment, fixtures and penetrations (**6.13**).

When designing reinforced bitumen membrane roofing, particular consideration should be given to the substrate, the control of water vapour, the method of attaching the roofing to the substrate, the strength of the reinforced bitumen membranes, the provision of protection, and the provision of access for inspection.

6.2 Falls and drainage

All flat roofs should be laid to a minimum finished fall of 1:80, and to achieve this a design fall of 1:40 should be used to ensure proper drainage as recommended in BS 6229:2003. In flat roofs covered by reinforced bitumen membrane roofing, trough gutters with a finished width of less than 500 mm should generally be avoided.

Rainwater outlets (RWOs) should be sited and firmly fixed at low points in the general roof area, well clear of other penetrations, upstands and parapets. Their ideal location can be best determined during the laying of the vapour control layer.

The selection of a roof outlet assembly is dictated primarily by the construction of the roof, by its usage, by associated load-bearing requirements, by the area to be drained, and by the number of acceptable downpipes. Detailed guidance is given in BS EN 12056-3, which indicates that no roof area should rely upon a single RWO.

To allow proper and effective installation of the roofing membranes, outlets should be positioned no closer than 500 mm from other penetrations or details. The exception would be purpose-designed parapet or balcony outlets.

Generally, the efficiency of a rainwater outlet and its maximum flow rate increases with the available head of water. Where possible, therefore, outlets should be installed at the base of a localized sump to provide a good minimum head of water.

NOTE If the roof outlet body incorporates an angled profile of between 30° and 60° leading into the throat of the outlet, it will have the greatest potential flow rate.

Rainwater downpipes should be designed to accommodate vertical movement where they connect to the spigots of rainwater outlets set in a flat roof.

Rooflights, tank rooms and plant housings should be carefully designed in three dimensions, to allow the proper formation of the waterproof layer, and not interfere with the general drainage fall.

Properly designed cricket systems should be used to improve drainage between roof outlets and around any obstructions (e.g. rooflights or plant rooms).

Where significant differential movement is anticipated between deck and skirting an independent upstand construction should be employed.

When designed to the minimum finished falls, a small amount of transient ponding might be expected, e.g. behind laps. This is unlikely to have a detrimental effect on high-performance flexible reinforced bitumen membranes.

6.3 Dead and imposed loads

Dead and imposed loads should be determined in accordance with the recommendations of BS 6399-1 and BS 6399-3.

In any modification to a flat roof which might involve a significant change in the dead and/or imposed loadings, the advice of a structural engineer should be sought.

The roof covering, and insulation where applicable, should have adequate strength and stiffness or be protected to resist, without failure and perforation, the dead and imposed loads, wind loads and point loads.

NOTE This is particularly important when designing roofs that will carry heavy traffic, or areas including plant items.

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6.4 Design wind loads

Wind loads appropriate to the exposure, roof height, building shape, topography and location in the UK should be determined in accordance with the recommendations of BS 6399-2.

BS 6229:2003 also highlights the need to establish which is the critical layer within the roof build-up.

Decking panels should be fixed to the structure as described in **5.1**, or additionally as required for the specific site or location. In all cases, the decking should have sufficient fasteners to safely resist the maximum wind uplift expected.

The resistance to wind uplift should be calculated from the strength characteristics of the bonding agent or fixing devices and from the dead weight resistance of the covering.

Reinforced concrete decks and sand/cement screeds should normally be substantially airtight, hence the critical layer will be the deck.

Boarded constructions with square-edged or tongued joints or metal decking not otherwise sealed should be regarded as wholly air-permeable for the purposes of consideration of the attachment of the roof finishes. Here, the critical layer will be the vapour control layer or roof covering, and the wind uplift pressure is exerted on the substantially air-impermeable layer.

In such cases, adequate bonding or mechanical connections between the air-impermeable layer and the deck should be made to resist the wind uplift pressure (less the appropriate dead weight).

On inverted roofs, the loading provided by the ballast (shingle, paving, or garden roof) should be adequate to withstand the combined effects of wind uplift, flotation and wind scour. See also BRE Digest 311 [7].

For proprietary lightweight systems, the manufacturer's recommendations should be followed.

6.5 Structural strength, stiffness and deflection limits

The substrate onto which reinforced bitumen membrane roofing is to be laid should be sufficiently rigid, dense and dimensionally stable to support the membranes, insulation, surface protection and any plant or other items.

BS 6229:2003 describes in full the range of substrates, and their relevant codes of practice. The substrate's nature will be largely determined by the type of roof selected (warm deck, cold deck, or inverted) and the substrate will in turn have a direct influence on the method of attaching the reinforced bitumen membrane roofing.

The structural deck should be designed for strength and stiffness in accordance with the recommendations of the relevant codes of practice.

6.6 Movement

High performance membranes can accommodate most minor movement, but if required, this can also be provided for by partial attachment of the relevant layer. Allowance should be made in the roof design for major structural movement as recommended in BS 6229:2003 and major movement joints in the structure should be reflected in the roof deck and the roof covering.

Raised movement joints should not interfere with drainage falls.

For a typical movement joint, see also Figure 15.

Differential movements or stresses in the roof membrane are more severe in warm roofs because of the greater temperature difference that normally exists between the roof covering and the insulation.

To reduce or minimize this temperature difference, a light-coloured surface finish should be chosen (see also **6.12**).

6.7 Protection against trapped moisture

Experience has shown that failures in flat roofs are often caused by the harmful effects of moisture trapped during construction, and great care should be taken to minimize such risks. Trapped water can be the result of using wet materials, water from in situ concrete and wet screeds, or rain on unprotected construction.

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The risk of trapping water during construction should be reduced as much as possible by laying successive roof layers with the minimum of delay, providing temporary weather protection during construction and interruptions, and, in exceptional cases, installing a temporary roof with sufficient working headroom over the roof to be constructed. Weather forecasts available from the Meteorological Office (www.met-office.gov.uk) could assist in planning the roof construction. Work on laying roof coverings and other moisture-sensitive layers should not be allowed to proceed in severe or continuously wet conditions.

Excess water in concrete slabs and concrete decks cast in situ should be drained downwards through temporary drain holes formed in the area of maximum sag of the roof deck. Subject to checking their effect on structural strength, the holes should be not less than 25 mm diameter, positioned to avoid reinforcement bars in the concrete and at approximately 3 m spacings.

The holes should not be re-filled before seepage and damp have ceased, but they should be filled with cement-sand mortar before finishing work on the ceiling is commenced. Pre-cast concrete roof decking units with open joints are self-draining and holes are not required, but if the joints are to be subsequently sealed, they should be left open for as long as possible.

Roofs with permanent steel shuttering will take longer to dry out properly, and therefore mechanical extraction processes should be used, ideally before the waterproofing is installed.

Reliance should not be placed on drying out trapped water by roof ventilators.

6.8 Thermal design — Choice and location of insulating materials

The types of flat roofs, warm, inverted, and cold, are defined by the location of the insulation in the build-up (see **3.12**, **3.13** and **3.14**). BS 6229:2003 also covers this topic in considerable detail.

The warm roof incorporates a vapour control layer and a rigid insulation board above the roof deck, keeping the decking close to internal temperatures, i.e. warm. It does not require ventilation, and should be designed to prevent harmful condensation from occurring. In this construction the insulation will remain dry, and the thermal values will remain stable.

In order to support the loads imposed by traffic, insulation boards for use in warm roofs should be capable of resisting permanent deformation or damage when subjected to concentrated loads. They should also have an even dust-free surface and sufficient laminar strength to resist, with a margin of safety, any stress imposed by wind uplift forces acting on the membrane system.

The inverted (or protected membrane) roof has insulation boards laid above the waterproofing membranes, and thus reduces the thermal stress upon the membranes. The boards should be ballasted against flotation and wind uplift, and this system is popular for terraces, when used with paving slabs, or for garden roofs.

NOTE 1 Only extruded expanded polystyrene (XPS) is currently in use as an inverted roof insulation.

NOTE 2 Moisture uptake can reduce the thermal efficiency of XPS insulation in the long term.

In a cold roof, the waterproofing is laid directly onto the deck, and any insulation is located above the ceiling, causing the decking to become colder.

Cold deck roofs should be avoided, due to the limitations of providing adequate ventilation above the insulation to prevent condensation, and the associated thermal losses. See also BS 5250.

Reference should be made to Clause **5** for detailed recommendations regarding substrates and their preparation to receive reinforced bitumen membrane roofing.

6.9 Control of condensation

Provision for the control of surface and/or interstitial condensation within the roof should be determined as recommended in BS 6229:2003, which includes Table A.2 on internal conditions. The method of calculation is referred to in BS 5250.

In warm deck roofs, most types of structural deck in use will provide a suitable surface for the support of the vapour control layer (VCL). Where a high level of vapour resistance is required it might be necessary to provide a two-layer vapour control layer, or to use a proprietary foil-laminated bitumen membrane.

On profiled metal decks, which do not provide a fully supporting substrate, it is more difficult to form an effective vapour control layer. Extra care should be taken to ensure adequate sealing of side and end laps, which might require the provision of additional support for the end laps.

This can be achieved by installing a polyester-cored bitumen membrane layer, followed by a metal-foil-cored layer, or by mechanically fixing a continuous board or sheet substrate to the deck before applying the vapour control layer, or layers.

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Laps should be staggered with two-layer systems.

Because of the self-sealing nature of reinforced bitumen membrane roofing materials, the water vapour resistance levels quoted will not be reduced significantly by the penetration of mechanical screw fixings. However, it should be established that the type of mechanical fixings used will be resistant to corrosion.

The inverted warm deck roof does not require a separate vapour control layer as the main waterproofing performs this function. Decks supporting an inverted roof system should have some thermal mass to attenuate rapid fluctuations in deck temperature, and to reduce the risk of condensation at deck level during prolonged periods of rain. If this type of construction is used, it is essential that the thermal design and thermal mass requirements are fully understood and calculated, to avoid condensation problems.

6.10 Sound insulation

Basic guidance on sound insulation can be found in BS 6229:2003. In critical situations, it is recommended to seek advice from a qualified acoustic consultant.

6.11 Fire precautions

The design and construction of flat roofs should meet relevant Building Regulations. The current Building Regulations require a fire resistance rating of Ext F. AC, when tested to BS 476-3:2004. This can be provided by mineral or metal-foil-finished reinforced bitumen membrane roofing.

Higher levels can be achieved using proprietary systems or ballast protection.

6.12 Surface protection

All reinforced bitumen membrane roofing, including upstands and detail works, should be protected against degradation and mechanical damage to extend its service life.

Types of surface protection are listed in Table 3 and Table 4.

Table 3 — Types of roof surface protection

Surface protection	Slope/pitch of roof
Mineral surfaced, or metal foil-faced capsheet	At any pitch
Stone aggregate bonded in dressing compound	Pitches up to 5°
Ballast or aggregate, laid loose	Pitches up to 2°
NOTE 1 Mineral-surfaced or metal-foil-faced capsheets provide the required protection against UV degradation; however, they will not mask imperfections or minor changes of level in the substrate. NOTE 2 Stone aggregate, ballast or paving slabs or tiles will in addition give maximum protection against mechanical damage. NOTE 3 Solar reflective paint finishes may be used on limited-access roofs to give added solar protection. These are best recommended to be applied over mineral-surfaced bitumen membranes in accordance with the manufacturer's instructions.	

Table 4 — Types of roof surface protection — Specific applications

Roof application	Surface protection
Inverted roof	Insulation and ballast (pre-cast concrete paving slabs, shingle ballast), or proprietary lightweight systems
Access roof or walkway	Pre-cast concrete paving slabs, proprietary paving tiles, or additional proprietary walkway membrane.
Terrace roof	Pre-cast concrete paving slabs or proprietary paving tiles
Gutter beds	Mineral-surfaced or metal-foil-faced capsheet
Exposed flashings and detail work	Mineral-surfaced or metal-foil-faced capsheet
Green/garden roofs	Seek manufacturer's advice

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6.13 Roof plant and equipment, fixtures and penetrations

To maintain the integrity of the waterproofing, the number of penetrations for plant and equipment should generally be minimized, and pipes, etc. grouped and routed to simplify the weathering of the penetrations.

Proprietary weathering systems and supports are available to ensure simple, weather-tight details. Co-ordination between the roofing designer and the services engineers at the design stage is essential. (See also **8.19**.)

To facilitate access for regular inspection, maintenance and repair (as recommended in BS 6229:2003) consideration should be given to provision of appropriate, safe access to all flat roofs.

7 Design of reinforced bitumen membrane roofing

7.1 General

In addition to the general design considerations described in Clause **6**, there are specific factors which apply to the formation of roof coverings using reinforced bitumen membranes. These are:

a) choice of materials;

b) methods of attachment;

c) sloping and vertical work; and

d) the practicality of design details.

Design decisions should be clearly and unambiguously described, specified and detailed.

7.2 Choice of materials

The design of the reinforced bitumen membrane roofing should include selection of the individual layers of bitumen membrane, and the bonding compound or other attachment method, before consideration of the detail work at, for example, eaves, parapets, upstands and penetrations.

The first layer of bitumen roofing membrane should be selected according to the type of substrate on which it is to be applied and the proposed method of attachment (see **7.3**).

The top layer or cap sheet should be selected having regard to the requirements for protection, fire resistance, appearance, solar reflectivity, roof access and traffic and any special requirements for resistance to chemical contamination or deposits.

Any intermediate layers fully bonded between the first layer and the top layer will produce a cohesive composite membrane and augment the mechanical properties of the bitumen membrane roofing to provide the required level of durability and resistance to stress.

The grades of bonding compound (listed in **5.6.3**) should be selected according to the slope of the roof, and the specific requirements of the application. The most appropriate grade should be agreed having regard to the prevailing conditions on each project.

Different types of flexible reinforced bitumen membranes (listed in **5.4**) combined as described in this standard, will form bitumen membrane roofing with different grades of performance.

Higher grades of membranes, giving longer service life, are likely to have higher initial cost than lower grade ones; they can also be expected to have lower maintenance costs.

7.3 Methods of attachment

7.3.1 *General*

With the possible exception of inverted and/or ballasted roofs, reinforced bitumen membrane roofing should be suitably attached to the substrate, and to each subsequent layer, in order to resist wind uplift forces. The edges of the roof should be closed off against entry of air to the underside of the waterproofing.

When considering the effects of wind uplift forces, careful consideration should be given to the method of attaching the whole roof covering, including any insulation and vapour control layer.

At all perimeters and changes of level, the fixing of kerbs, battens and the like should be robust enough to provide a secure mounting for the membrane system.

Although general guidance on attachment is given within this code of practice, further advice should be sought from individual manufacturers or specialist advisors.

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7.3.2 *Vapour control layers*

7.3.2.1 *General*

To provide an effective vapour control layer (VCL), the reinforced bitumen membrane, or other suitable product, should normally be securely attached by bonding or fastening to the supporting substrate in order to resist the design wind pressure, and with all joints lapped by 75 mm and bonded.

Bonding can be with hot bitumen, torching, hot air bonding, or with a suitable cold adhesive as appropriate.

Torching of the VCL is not recommended, unless it has been specifically designed for torch application and the roof deck is non-combustible.

When bonding reinforced bitumen membranes, supporting decks should be primed with a suitable primer and allowed to dry, prior to the installation of the vapour control layer, except when bonding to either plywood or OSB boards.

Self-adhesive membranes can be suitable, depending upon the ambient temperatures and should be installed according to the manufacturer's specific instructions. Care should be taken to ensure that the adhesion strength of the membrane to the deck is sufficient for the wind uplift requirements of the building location. All types of deck should be primed and allowed to dry.

Self-adhesive VCLs should only be used on very even, smooth surfaces. Certain types of adhesives require minimum material temperatures, and might require warming before adequate adhesion can be achieved, i.e. they have limited installation windows.

In the case of ballasted roofs, or where the thermal insulation and/or waterproofing is to be mechanically fastened, then priming might not be necessary and the VCL can be loose laid, so long as all joints are lapped a minimum of 75 mm and bonded.

At all edges, abutments and penetrations the VCL should be either turned back at least 150 mm onto the insulation and sealed down or turned up and sealed to the main roof covering for at least 50 mm, to encapsulate the insulation.

See detail drawings in Figure 5, Figure 7, and Figure 9 to Figure 16.

A range of proprietary VCL products are available, particularly where the insulation and/or waterproofing is to be mechanically fastened, but general requirements for differing supporting decks are:

7.3.2.2 *Concrete or screeds*

On existing roofs or over unheated buildings, the VCL should be equivalent to or better than BS 747:2000 type 3B.

Over high humidity or heated buildings, the first layer should be a preparatory layer of BS 747:2000, type 3G for a pour-and-roll system, and a proprietary perforated layer for torch-on systems. For both systems, the VCL should be an aluminium-cored bitumen membrane.

7.3.2.3 *Close-boarded timber*

A high performance membrane at least equivalent to a BS 747:2000, type 5U, nailed at maximum 150 mm centres, as detailed in **7.3.4**d). In high humidity buildings (kitchens, bathrooms, etc.), the nailed layer should be overlaid with a suitable, fully bonded aluminium-cored VCL.

7.3.2.4 *Timber derivatives, including plywood and OSB boards*

To allow minor movement, and to prevent the penetration of hot bonding bitumen if used, all panel joints should be covered, using bitumen membrane tape (at least equivalent to BS 747:2000, type 5U), minimum 100 mm wide. The bitumen tape should straddle the joint and should be fixed or bonded on one side of the joint only to maintain its position.

7.3.2.5 *Profiled metal*

The crowns of the deck should be primed and allowed to dry. A high performance membrane at least equivalent to BS 747:2000, type 5U should be bonded to the crowns using hot, mopped bitumen or a suitable cold compound. In high humidity buildings, this should be overlaid with a suitable aluminium-cored VCL, or a polyester-reinforced, aluminium-cored VCL used instead.

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7.3.2.6 *Existing bituminous waterproofing (being overlaid)*

If the existing waterproofing is to act as a VCL, it is imperative that the existing roof build-up is checked to ensure it is sound and adequately secured. Any splits or blisters should be repaired and the surface primed with a suitable bitumen primer. Priming might not be required where the new roofing is to be mechanically fixed. Should an additional VCL be required, this should be adhered by a full bond.

7.3.3 ***Thermal insulation***

The insulation boards should be sufficiently bonded to the vapour control layer or substrate to ensure adequate restraint. A full bond is unlikely to be achieved because of surface irregularities and variations in the substrate. Account should be taken of this when assessing resistance of the total roof covering to wind uplift, and a decision made whether to adopt mechanical attachment of the insulation.

Generally, the insulation should be adhered either in hot bitumen, with a proprietary cold adhesive, or mechanically fastened, using a minimum of four appropriate fixings within the area of each board (for a standard size of 600 mm × 1200 mm) or as specifically calculated for the project requirements. All joints should be close butted and cross-joints staggered to minimize cold bridging.

On inverted roofs, extruded expanded polystyrene (XPS) insulation boards are loose laid on top of the waterproofing, with ballast installed over a filter layer, or concrete paving slabs on supports or proprietary systems, to retain them. At roof edges, allowance should be made for board movement and continuity of insulation.

7.3.4 ***Bituminous membrane roofing***

Bituminous membrane roofing is generally applied in two or more layers of reinforced bitumen membrane, bonded together with sealed joints to form a continuous waterproof covering.

Specifically designed reinforced bituminous single-layer systems are available. These also have sealed joints, forming a continuous waterproof covering, and should be installed according to the manufacturer's instructions.

Attachment of reinforced bituminous membrane roofing is achieved by full bonding, by partial bonding, by mechanical fastening with screws and stress plates, or by nailing; the choice should depend upon the type of substrate, and the required resistance to wind uplift pressure. Self-adhesive membranes may also be used onto suitable substrates.

Advice from manufacturers should be sought to ensure that the correct method of attachment is followed for any particular substrate/membrane combination.

Also, wind uplift resistance might dictate the most appropriate choice.

The methods and their appropriate applications are listed as follows.

a) Full bonding by laying the membranes in hot bitumen should be used with substrates of cork, fibreboard, mineral fibre, cellular glass and perlite insulation boards. Fully bonded torch-applied membranes should only be used with non-combustible substrates and with surfaces designed to enable the torch application of subsequent layers. It is possible to install a torch-receivable first layer in hot bitumen, and then torch apply the second or capping sheet, which should be specifically designed for torching.

The practice of "blacking out" (applying oxidized bitumen on-site to the back of a bitumen membrane, to allow torch application) and then torching is *not acceptable*.

b) Partial bonding should be used to provide pressure release and accommodate minor movement over substrates of plywood, wood particleboard, OSB board, concrete (including cementitious screeds) and rigid polyurethane or polyisocyanurate boards.

Partial bonding is achieved either by using a perforated base layer, or by strip or spot bonding in hot or cold-applied bitumen, or by use of a specifically designed, partial bond torch-on membrane.

Cementitious substrates are likely to contain large quantities of moisture, which can be converted to water vapour by internal space heating and/or solar radiation, and cause pressure beneath the bitumen membrane roofing. In order to allow such pressure to disperse it is usual to select partial bonding of the first layer.

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c) Mechanical fastening of membranes is possible by installing a sacrificial layer mechanically fastened with screws and stress plates, or alternatively nails at maximum 150 mm centres, with subsequent layers fully bonded.

Specially manufactured membranes are also available for fastening with screws and stress plates along the lap, with joints then sealed by torching or by hot air.

The manufacturer's advice should be sought as to the suitability of their membranes for mechanical attachment.

d) Direct attachment to close-boarded or tongue-and-grooved timber decks should normally be by nailing. The first layer for nailing should conform to at least BS 747:2000, type 5U or equivalent.

Nails should be spaced at maximum 150 mm cross centres over the field area, and at 50 mm centres around the roof perimeter and at all side and head laps. These should be at least 20 mm long, extra-large-headed galvanized steel clout nails conforming to BS 1202-1.

All the grades of bonding compound listed in **5.6.3** are suitable for forming reinforced bitumen membrane roofing, and the most appropriate grade should be agreed having regard for the prevailing conditions on each project.

The requirements for removal or retention of surplus bonding bitumen at edges of mineral-surfaced cap sheets should be clearly specified. For torch-on cap sheets, the presence of a slight bitumen bead at laps indicates that sufficient heating has been used, and is considered essential.

Annex A gives guidance as to resistance to wind uplift provided by each method of attachment, on different substrates, and with different surface protection. On each project, specialist advice should be sought to ensure that the method of attachment selected is appropriate to the design wind pressure for the site.

7.4 Sloping and vertical work

7.4.1 *Sloping work*

Specifications for sloping roofs are generally the same as for flat roofs, but with the following limitations (see also Figure 1, Figure 2 and Figure 3).

a) Felts (reinforced bitumen membranes) should be of suitable strength for nail fixing [see **7.3.4**d) for details].

Therefore BS 747:2000, type 3 (glass-based) reinforced bitumen membranes *should not be used*.

b) Similarly, surface finishes should remain stable at the design slope, therefore the recommendations given in **6.12** and Table 3 and Table 4 should be followed.

c) On slopes over 5°, a partially bonded membrane has insufficient adhesion or attachment to resist slippage. On sloping roofs, any insulation board or isolation/preparation boards used should allow a full bond of the waterproofing membranes.

d) On slopes over 5°, head laps should be nailed, with large-headed galvanized clout nails placed at 75 mm centres in two rows, with 50 mm between rows, to prevent slippage of bituminous membranes.

e) On substrates that cannot accept nailing, timber battens should be firmly fixed to the substrate at intervals according to Table 5.

f) Torch applied membranes should be nailed at head laps in the same fashion.

g) For specialist systems (e.g. cold-applied or self-adhesive) specific advice should be obtained from the manufacturer of the membranes.

h) Bitumen softens in hot sunshine, which reduces the adhesion of the membranes to the substrate. Therefore, on sloping roofs, due to the increased risk of slippage on slopes over 5°, Grade 115/15 bonding bitumen should be used, as it has a higher softening point and better adhesion. Grade 95/25 bitumen should not be used.

7.4.2 *Vertical work*

Skirting details between 150 mm and 250 mm height above the finished roof level do not normally require any mechanical restraint. The bitumen used on the main roof area will generally achieve sufficient resistance to slippage and/or slumping of the upstand.

Skirtings more than 250 mm high should be regarded as vertical work, and it will be necessary to mechanically fasten the membrane at the top edge.

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Depending on the construction of the detail, this can be achieved either by head nailing [see **7.4.1**d)] or by alternative fixing techniques, according to the specification.

Atactic polypropylene (APP)-modified torch-on membranes are more resistant to slippage and might be able to form taller upstands without requiring additional mechanical support, but specific advice should be obtained from the manufacturer.

For membranes manufactured with non-modified bitumen, used on taller upstands, a polyester base (minimum 150 g/m^2) should be selected.

7.4.3 *Applying waterproofing to sloping and vertical roofs*

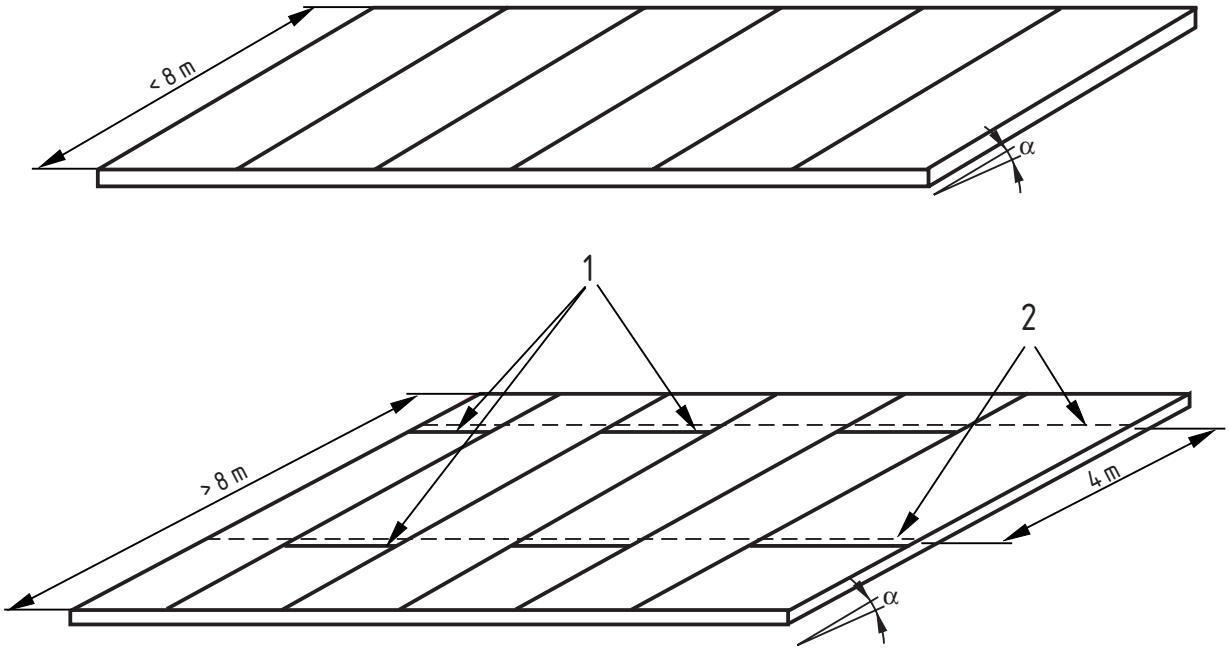
The reinforced bitumen membranes should be laid down the line of slope, and nailed at the head of the sheet.

In all cases, the intermediate laps of adjacent membrane runs should be staggered, with batten spacing and maximum membrane lengths as shown in Figure 1, Figure 2 and Figure 3 and Table 5. Additional mechanically fixed battens will be required for this.

Mechanical fastening of the insulation will be required in order to resist wind uplift.

Table 5 — Batten centres for pitched BUR roofs

Pitch, α	Length of pitched run m	Membrane lengths used m	Batten centres m
5° to 25°	Up to 8.0	8.0 (no head laps)	Ridge and eaves only
5° to 25°	Over 8.0	4.0	4.0 (plus ridge and eaves)
25° to 60°	Any	4.0	2.0 (plus ridge and eaves)
60° to vertical	Any	2.5	1.25 (plus ridge and eaves)



Key

1 Lap joint over mechanical fixings

2 Support battens for nailing per Table 5

NOTE All membranes nailed at ridge and eaves.

Figure 1 — Nailing reinforced bitumen membranes on slopes over 10° and up to 25°

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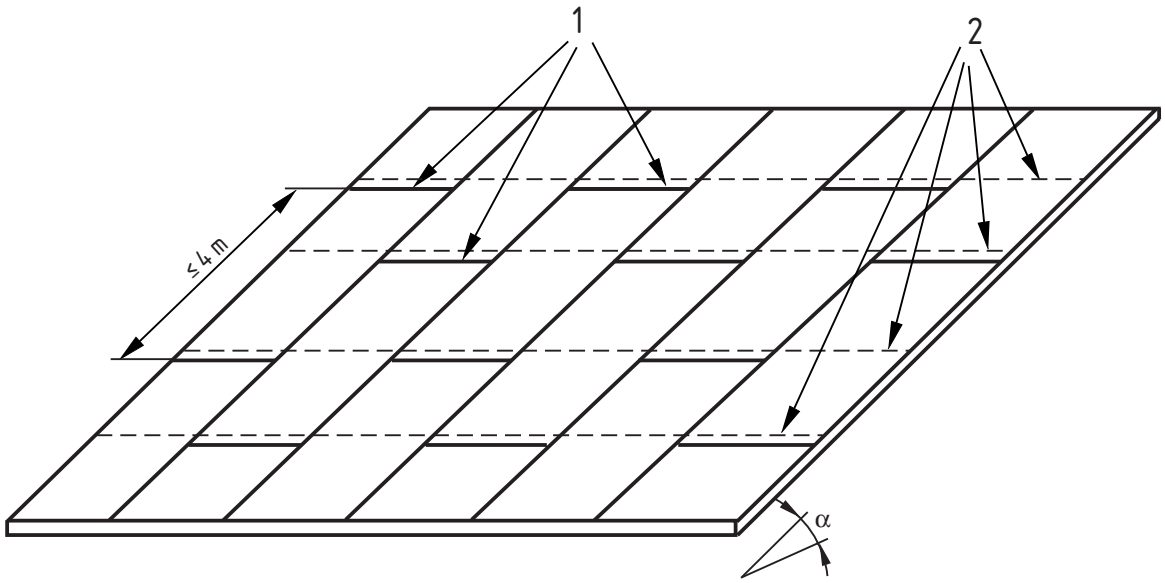

Key

1 Lap joint over mechanical fixings

2 Support battens for nailing per Table 5

NOTE All membranes nailed at ridge and eaves.

Figure 2 — Nailing reinforced bitumen membranes on slopes from 25° to 60°

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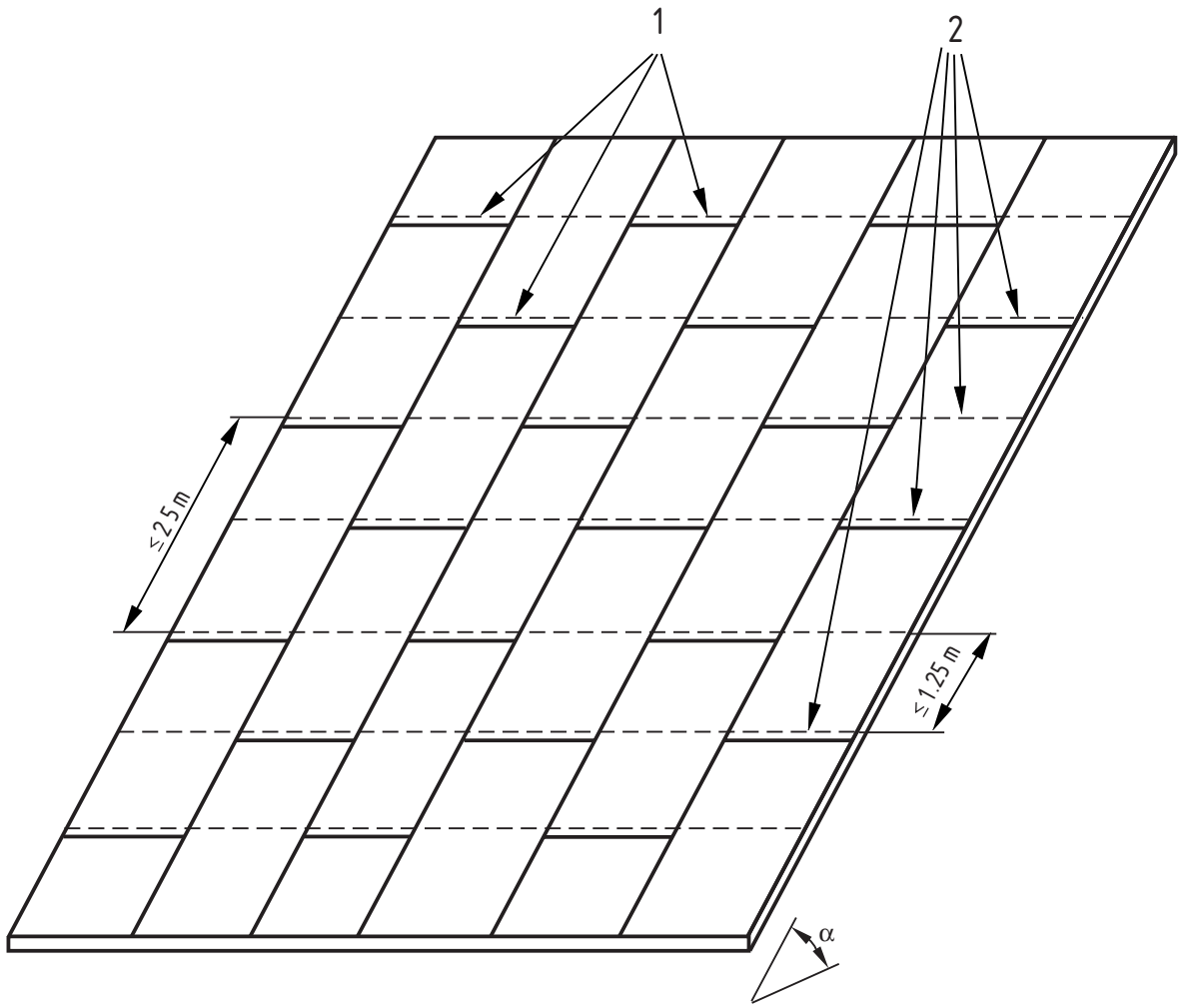

Key

1 Lap joint over mechanical fixings

2 Support battens for nailing per Table 5

NOTE All membranes nailed at ridge and eaves.

Figure 3 — Nailing reinforced bitumen membranes on slopes from 60° to vertical

7.5 Detail work

7.5.1 *General principles*

The general arrangement of details and the principles to be followed at gutters, verges, upstands, risers and expansion joints are shown in Figure 4, with detail drawings in Figure 5 to Figure 16.

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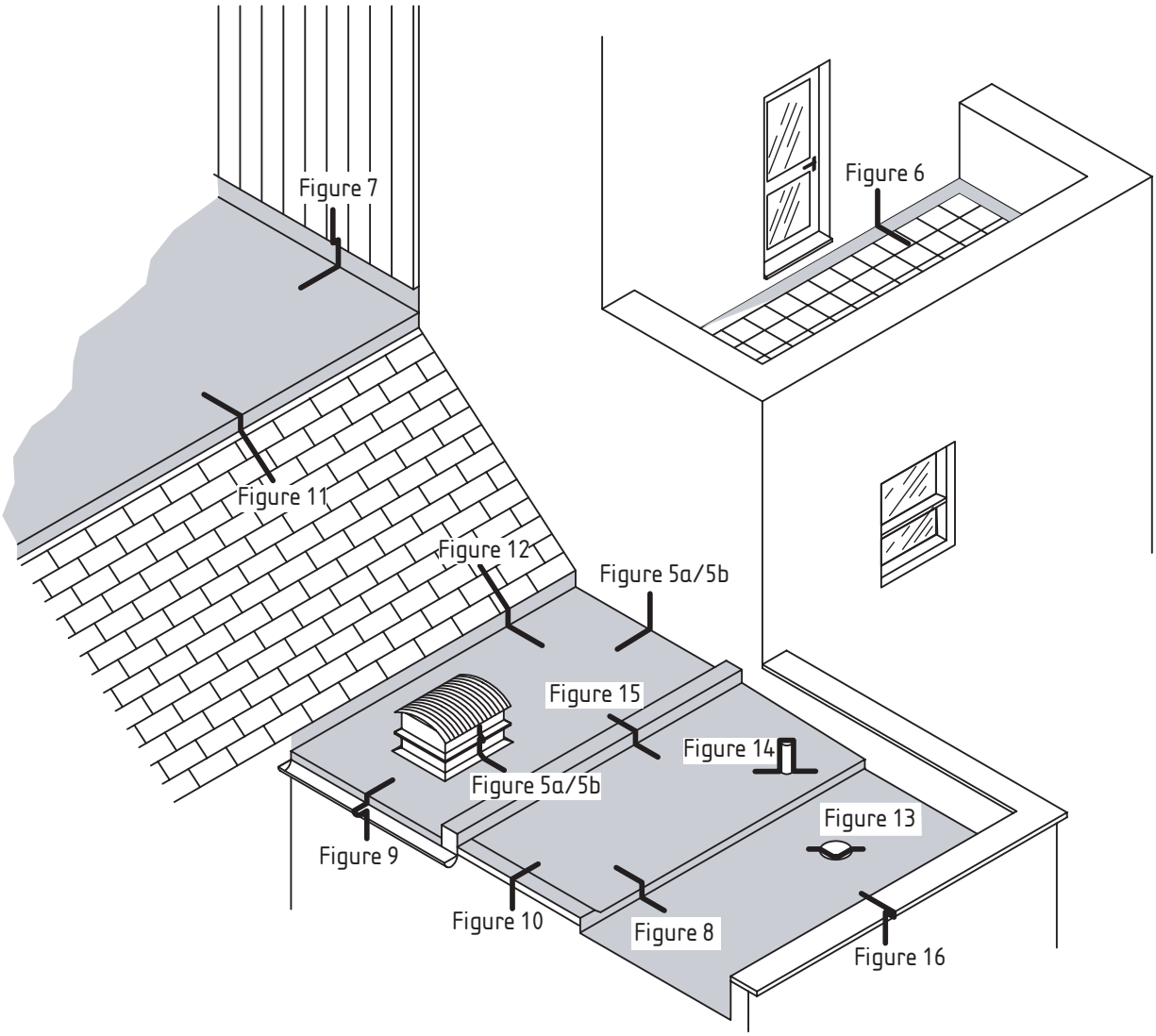

Figure 4 — General arrangement and detail locations

The integrity of detail work will depend upon proper overlapping of successive layers of reinforced bitumen membrane and staggering of the laps.

Where separate metal cover flashings are used they should be installed in accordance with the appropriate code of practice for the material used.

7.5.2 *Specific details*

The details in Figure 5 to Figure 16 are generic drawings only, showing the general principles of waterproofing, insulation and airtightness; they are indicative of current good practice.

a) For clarity and simplicity, the surface finishes (see **5.5**) have been omitted, except in the case of the inverted roof (Figure 6).

b) The membrane system is shown as two layers. This can vary depending upon, for instance, the method of attachment to the substrate, the type of insulation material or membrane, etc.

c) The thickness of insulation layers and other components are indicative only and they should not be scaled. Actual dimensions will depend upon the design specification.

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d) The configuration of laps will depend on the direction of the roll, the sequence of laying, and specific details.

e) The prevention/reduction of thermal bridging and the need for sealing of the junctions between the roof deck and the boundaries to produce an airtight envelope, is now an integral part of the Building Regulations [4].

NOTE 1 The cold deck roof is not illustrated (see **6.8**).

The details are:

— Figure 5, **Upstand — Warm deck roof** (a standard upstand with cover flashing, and a second option with a termination bar for reinforced concrete/similar upstands where a chase cannot be cut);

— Figure 6, **Upstand — Inverted roof** (with faced insulating board protecting upstand);

— Figure 7, **Independent upstand beneath cladding**;

— Figure 8, **Change in roof level at riser or side of trough gutter**;

— Figure 9, **Eaves detail**, welted drip shown;

— Figure 10, **Verge/check edge**, GRP edge trim shown (a welted drip could also be used);

— Figure 11, **Mansard edge**, showing position of lead flashing;

— Figure 12, **Pitched roof abutment** (the design and location of the insulation and ventilation provided for the pitched roof is not shown, but should be considered by the designer);

— Figure 13, **Rainwater outlet** (internal vertical outlet shown in a warm roof);

NOTE 2 No detail has been included for a rainwater chute through a perimeter parapet or similar, because the Committee feels that the traditional styles and designs are unlikely to meet the new Building Regulations.

— Figure 14, **Cold pipe penetration** (incorporating a “lead slate”);

NOTE 3 Hot pipes or flues will need special consideration.

— Figure 15, **Movement joint — Twin kerb**, pre-formed or proprietary copings could also be used over kerb as an alternative;

— Figure 16, **Parapet wall with coping detail**, proprietary pre-formed cappings, or coping stones bedded in mortar could also be used here.

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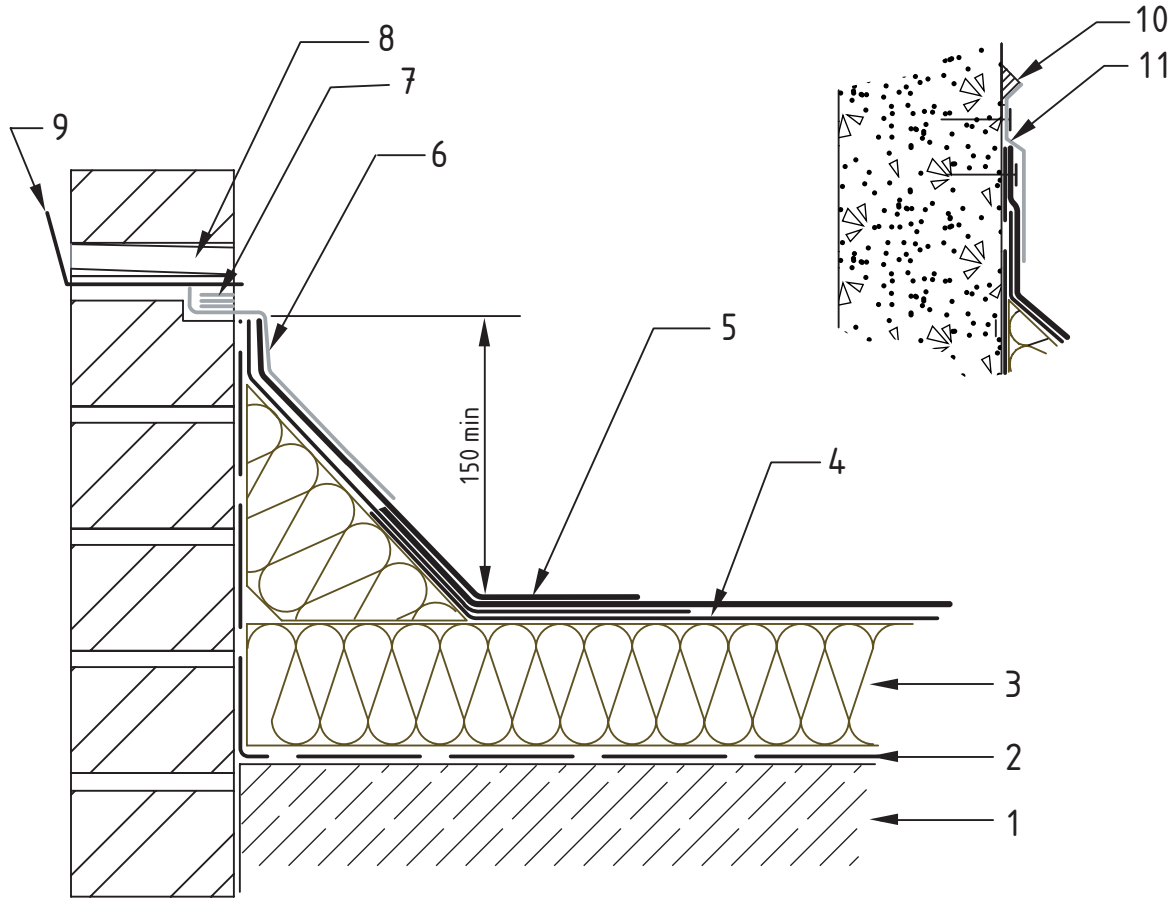

a) Insulating fillet option

Key

1 Substrate (e.g. concrete)
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Lead flashing
7 Lead wedge and pointing as appropriate
8 Weephole
9 DPC/cavity tray
10 Metal cover flashing (for concrete upstands)
11 Sealant fillet (for concrete upstands)

Figure 5 — Upstand — Warm deck roof

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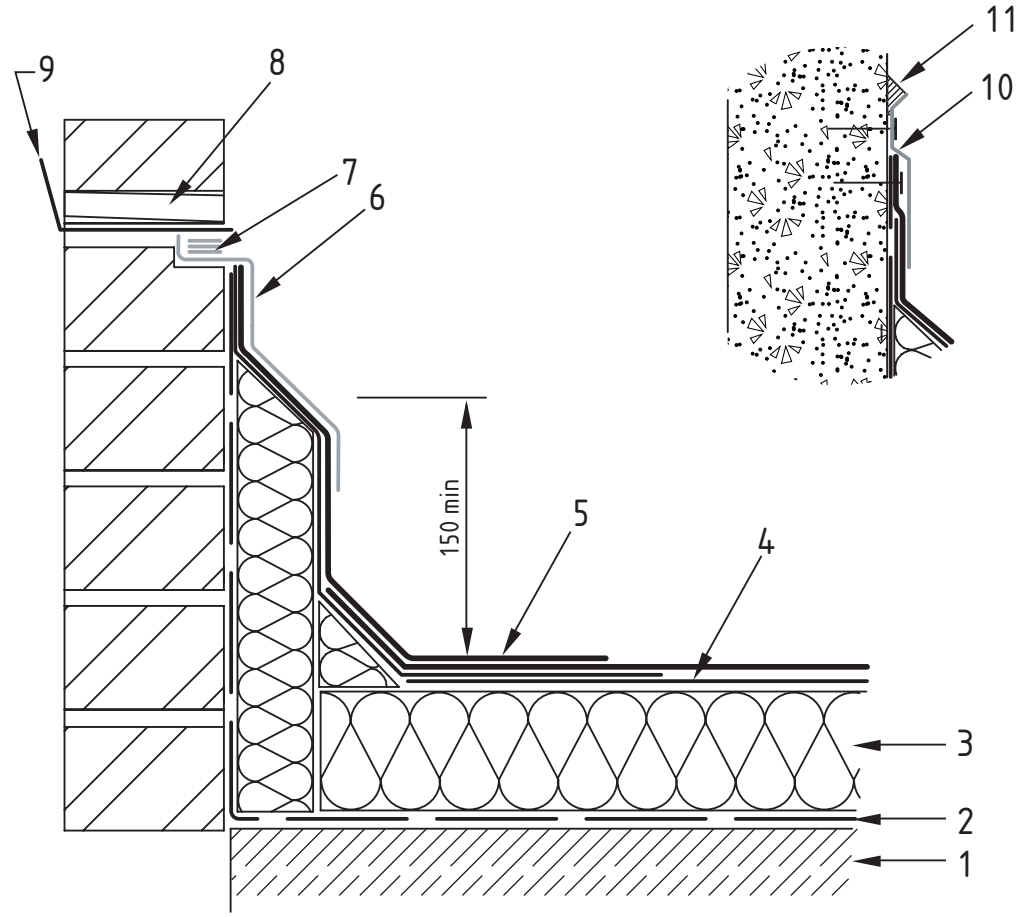

b) Vertical insulation option

Key

1 Substrate (e.g. concrete)
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Lead flashing
7 Lead wedge and pointing as appropriate
8 Weephole
9 DPC/cavity tray
10 Metal cover flashing (for concrete upstands)
11 Sealant fillet (for concrete upstands)

Figure 5 — Upstand — Warm deck roof (*continued*)

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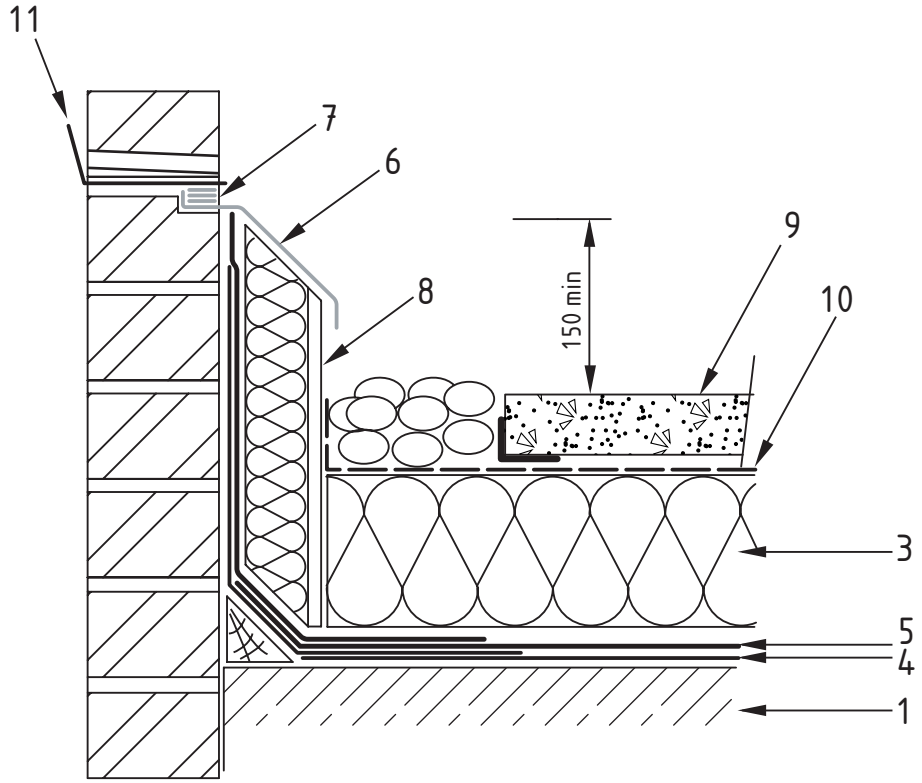

Key

1 Substrate (e.g. concrete)
2 Vapour control layer (not applicable)
3 XPS insulation
4 Underlay
5 Capsheet
6 Lead flashing
7 Lead wedge and pointing as appropriate
8 Protected XPS insulation board
9 Pavior/shingle ballast
10 Filter layer
11 DPC/cavity tray

Figure 6 — Upstand — Inverted roof

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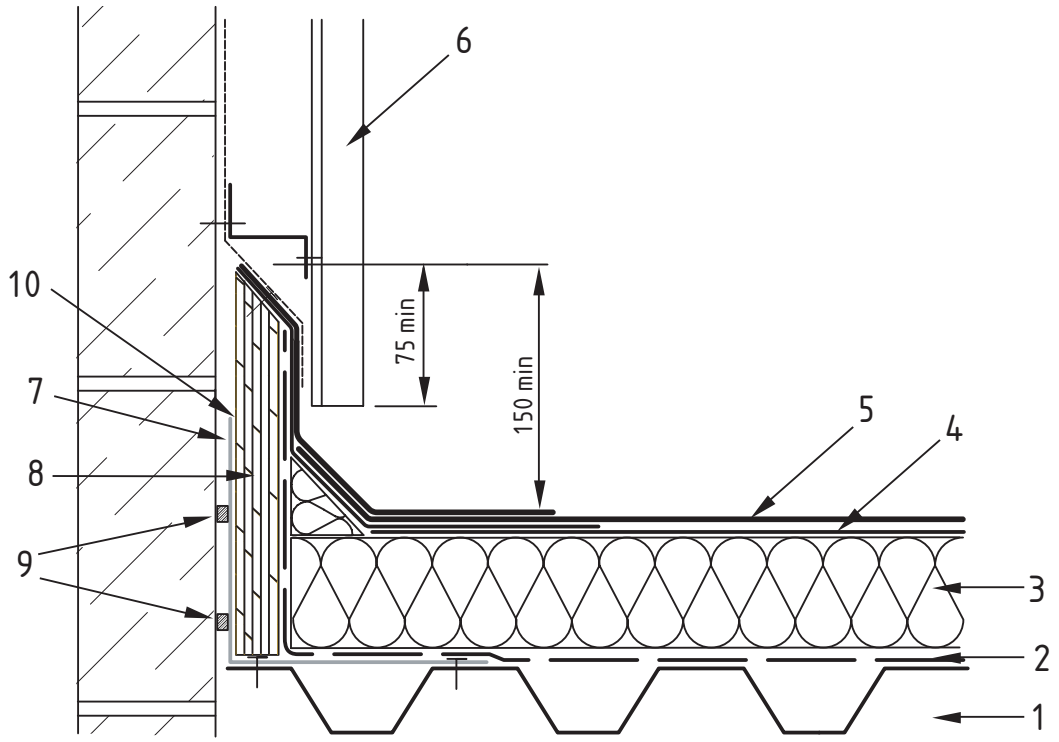

Key

1 Substrate (lightweight)
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Vertical cladding (air permeability sealing between felt upstand and cladding should be considered)
7 Galvanized steel support (for 8)
8 Plywood upstand (with insulations if required)
9 Air seal
10 Vertical leg of the galvanized steel support, shorter than the plywood upstand to avoid thermal bridging

Figure 7 — Independent upstand beneath cladding

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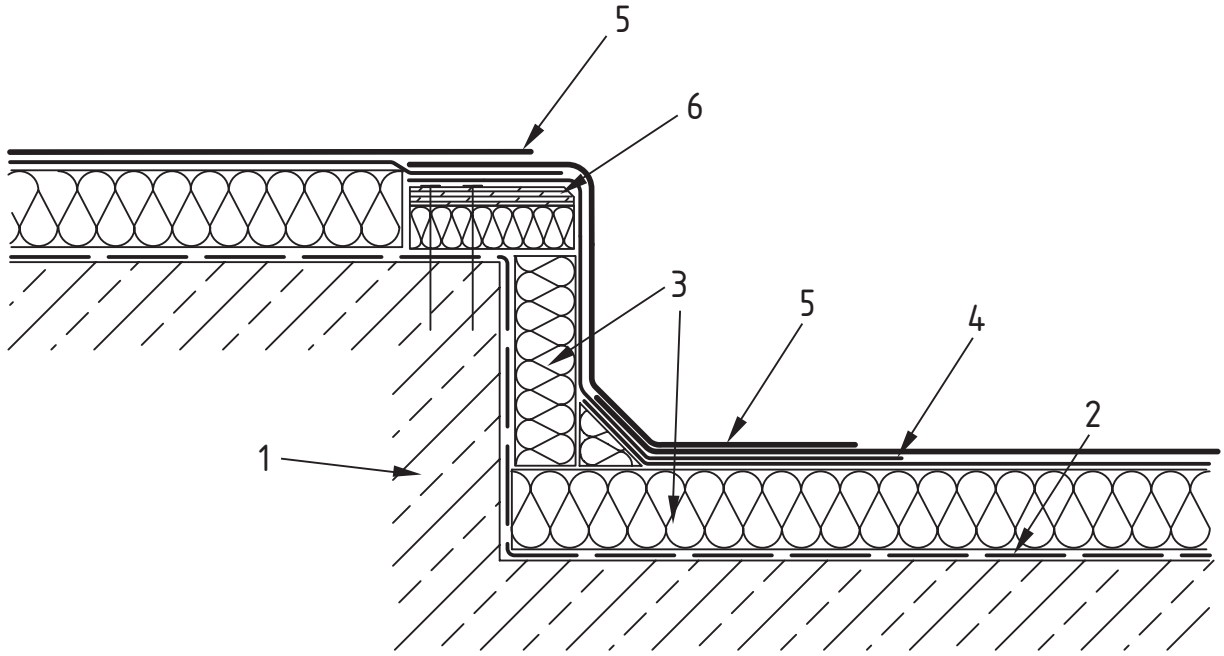

Key

1	Substrate	4	Underlay
2	Vapour control layer (VCL)	5	Capsheet
3	Insulation	6	Plywood-topped insulation section, fixed to substrate and chamfered, to act as a "hard edge"

Figure 8 — Change in roof level at riser or side of trough gutter

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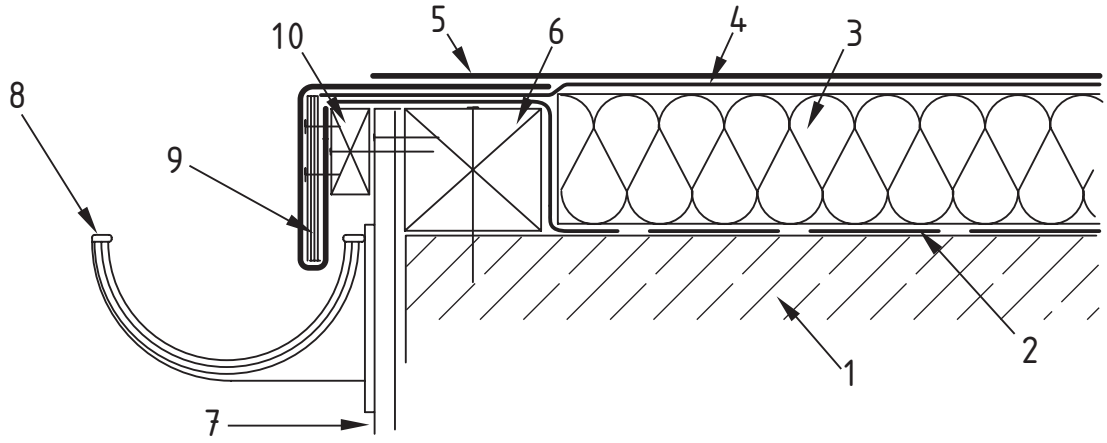
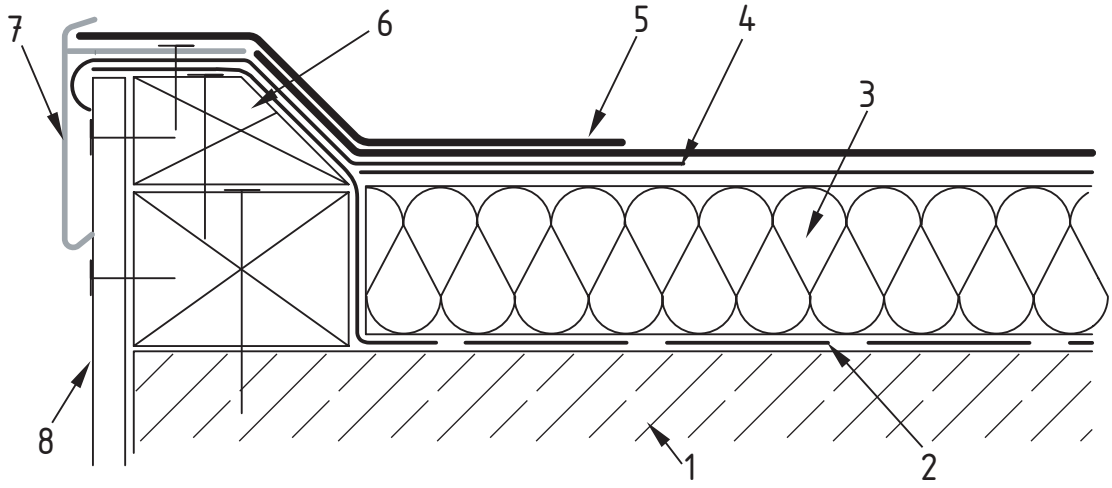


Key

1 Substrate
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Timber "hard edge"
7 Fascia board
8 Gutter
9 Optional former
10 Drip batten

NOTE Where substrate is a profiled metal sheet, profiled filler blocks and other measures might be required to seal and reduce thermal bridging through the wall/roof interface.

Figure 9 — Eaves detail



Key

1 Substrate
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Timber splay fillet
7 Edge trim, securely fixed to substrate
8 Fascia board

NOTE Where substrate is a profiled metal sheet, profiled filler blocks and other measures might be required to seal and reduce thermal bridging through the wall/roof interface.

Figure 10 — Verge/check edge

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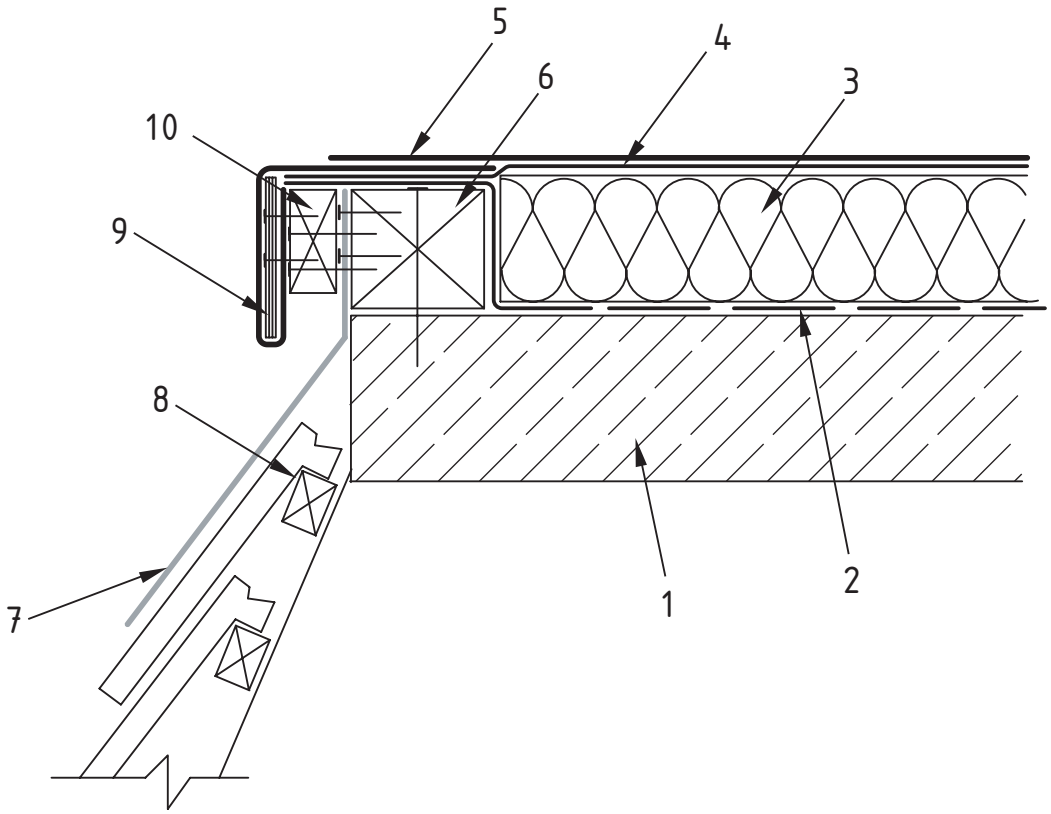

Key

1 Substrate
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Timber "hard edge"
7 Lead apron flashing, fixed in accordance with Lead Sheet Association guide
8 Batten and tiles/slates
9 Optional former
10 Drip batten

NOTE 1 All elements should be very firmly fixed to prevent peelback in high winds.

NOTE 2 To seal and reduce thermal bridging through the Mansard/flat roof interface:

a) where substrate is a profiled metal sheet, profiled filler blocks and other measures should be used;

b) careful consideration should be given to the sealing and insulation without thermal bridging of the interface between the pitched and flat roof elements (the full Mansard construction is not shown).

Figure 11 — Mansard edge

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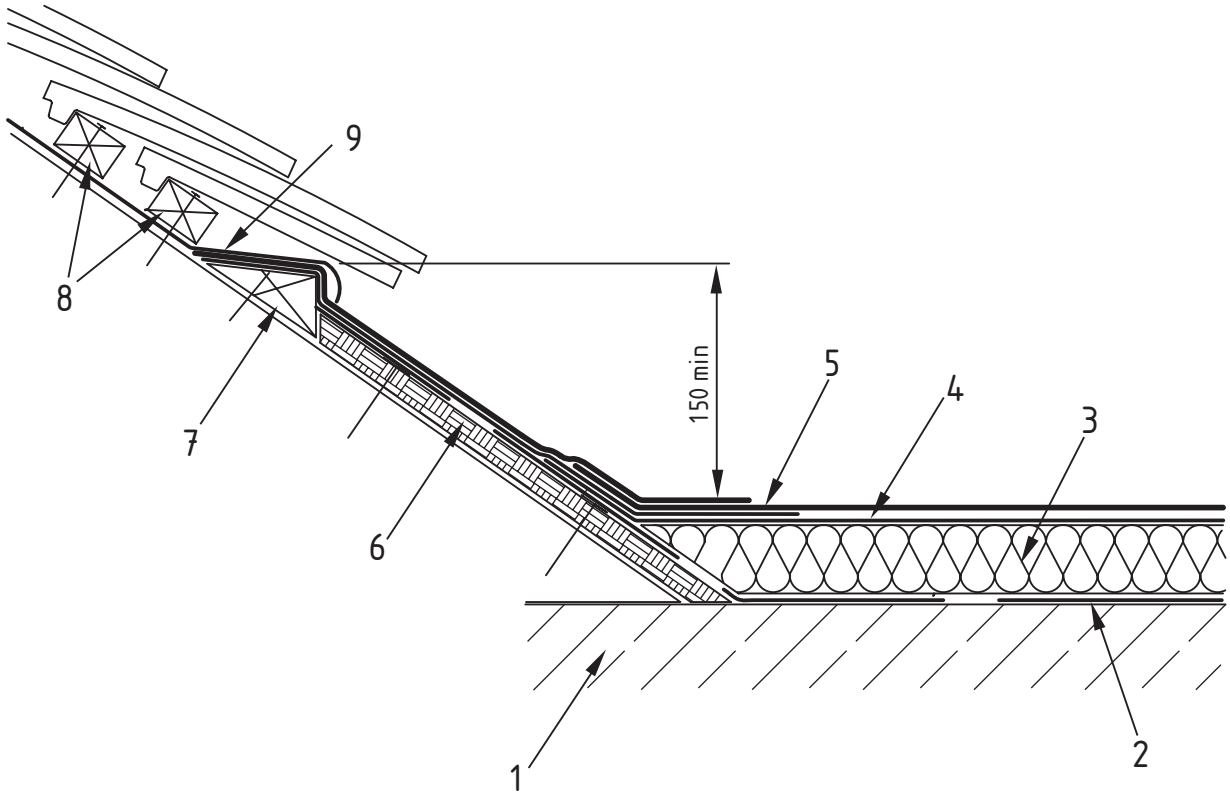

Key

1 Substrate
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Plywood/OSB layboard (insulated if required)
7 Tilt fillet (top face should fall towards the flat roof)
8 Tile batten
9 Sarking felt (side laps sealed to prevent capillary action pulling water into the roof void)

NOTE 1 Where substrate is a profiled metal sheet, profiled filler blocks and other measures might be required.

NOTE 2 The full-pitched construction is not shown; careful consideration should be given to the sealing and insulation without thermal bridging of the interface between the pitched and flat roof elements.

Figure 12 — Pitched roof abutment

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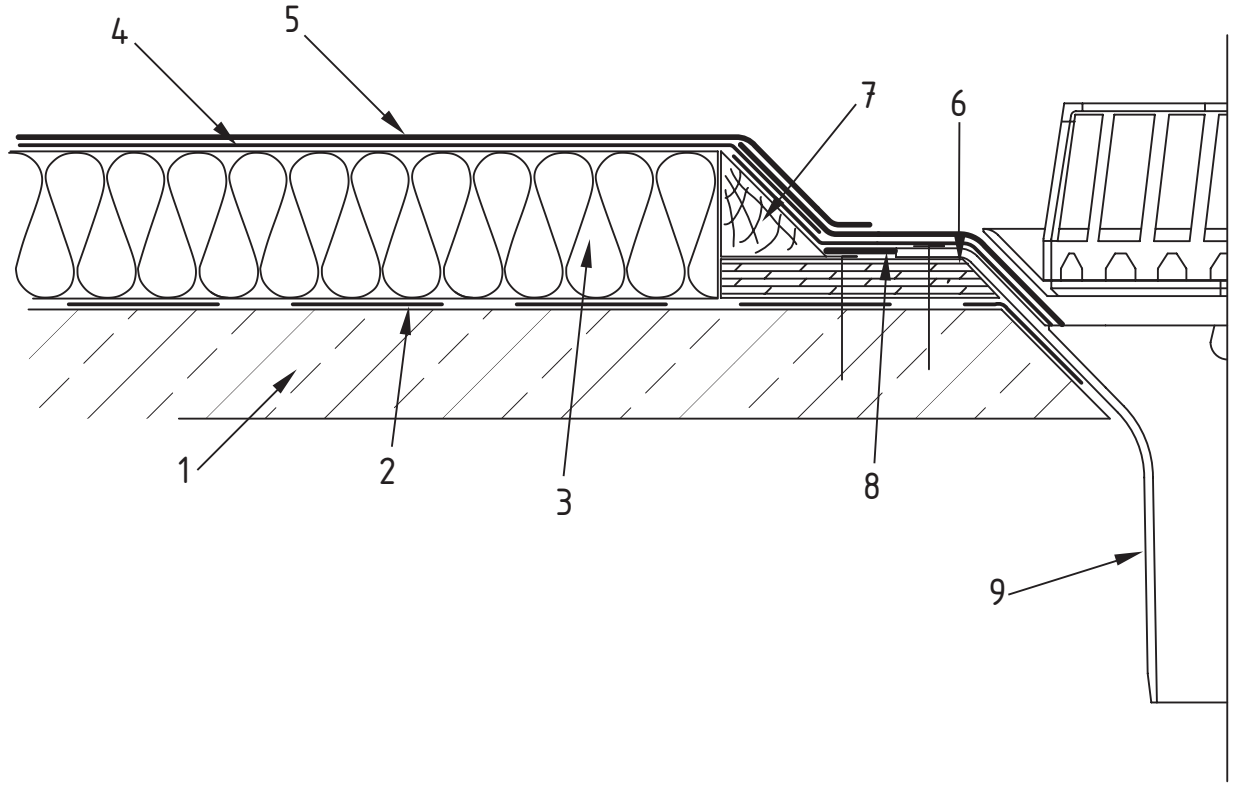

Key

1 Substrate
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Plywood sump base, fixed to substrate
7 Treated timber fillet
8 Felt infill piece
9 Proprietary rainwater outlet, fixed to substrate (and insulated if required)

Figure 13 — Rainwater outlet

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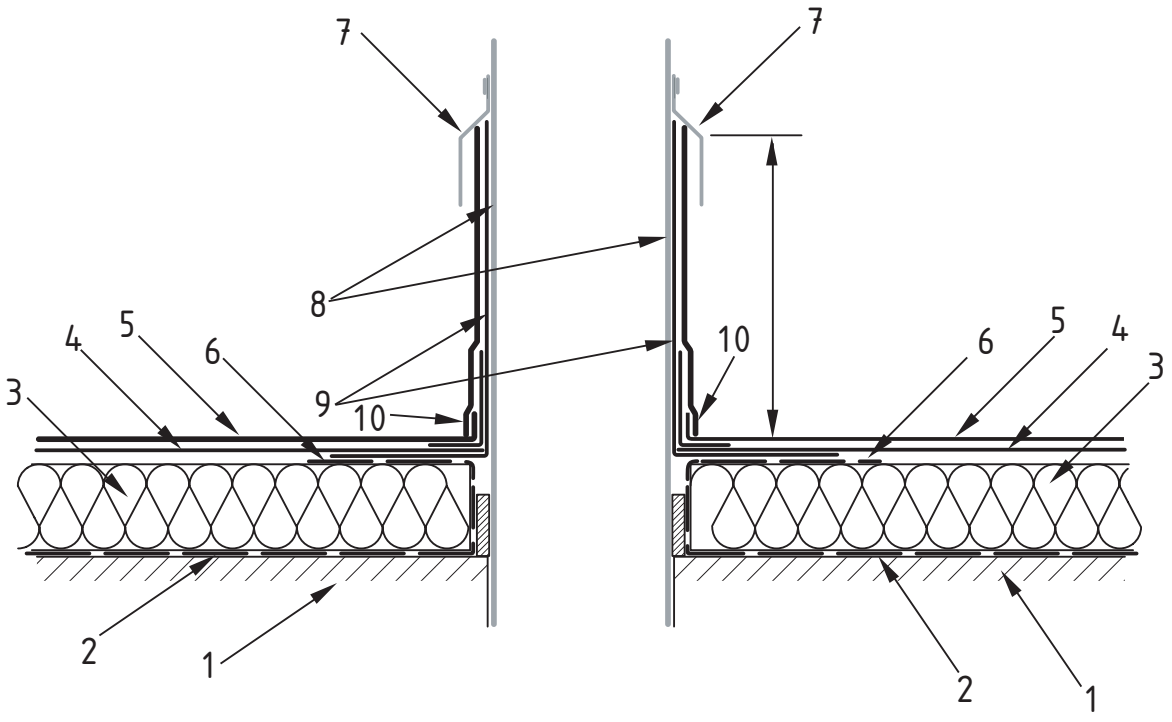

Key

1 Substrate
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 VCL wrapped back over insulation
7 Metal cowl or flashing
8 Cold pipe or penetration
9 Bespoke lead slate or soaker (primed)
10 Felt collar detailing
11 Air seal

Figure 14 — Cold pipe penetration

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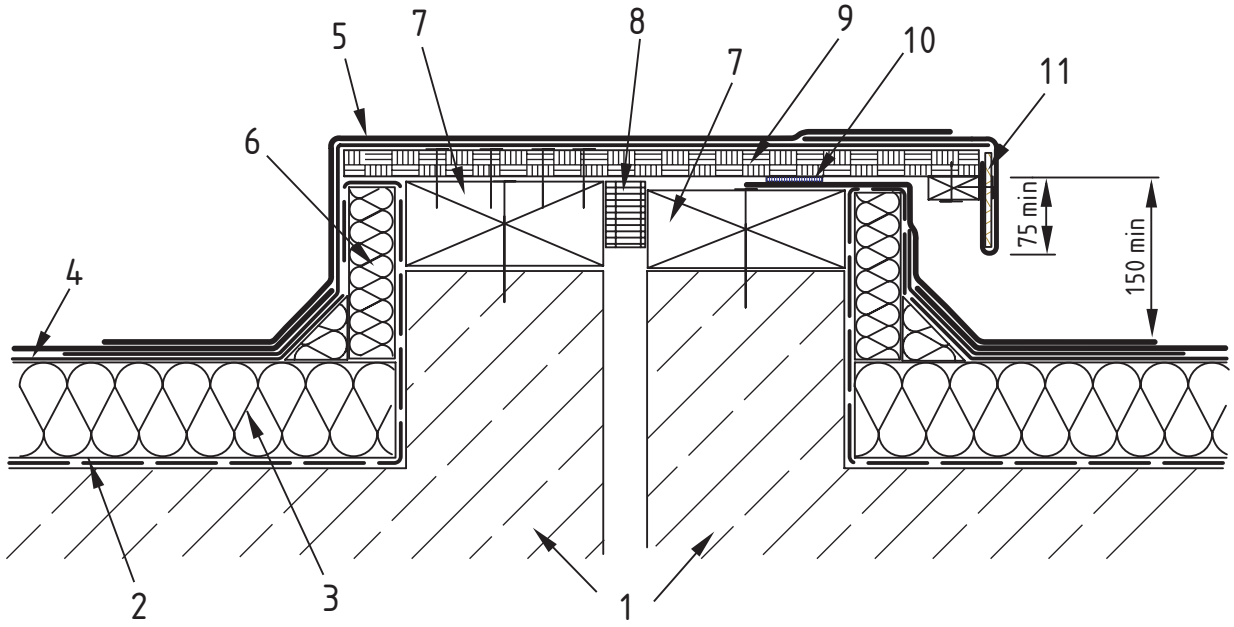

Key

1 Substrate
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Kerb insulation
7 Timber baulks to top
8 Non-flammable, compressible insulation
9 OSB3 or plywood capping (fixed one side only)
10 Air seal
11 Welted drip

Figure 15 — Movement joint — Twin kerb

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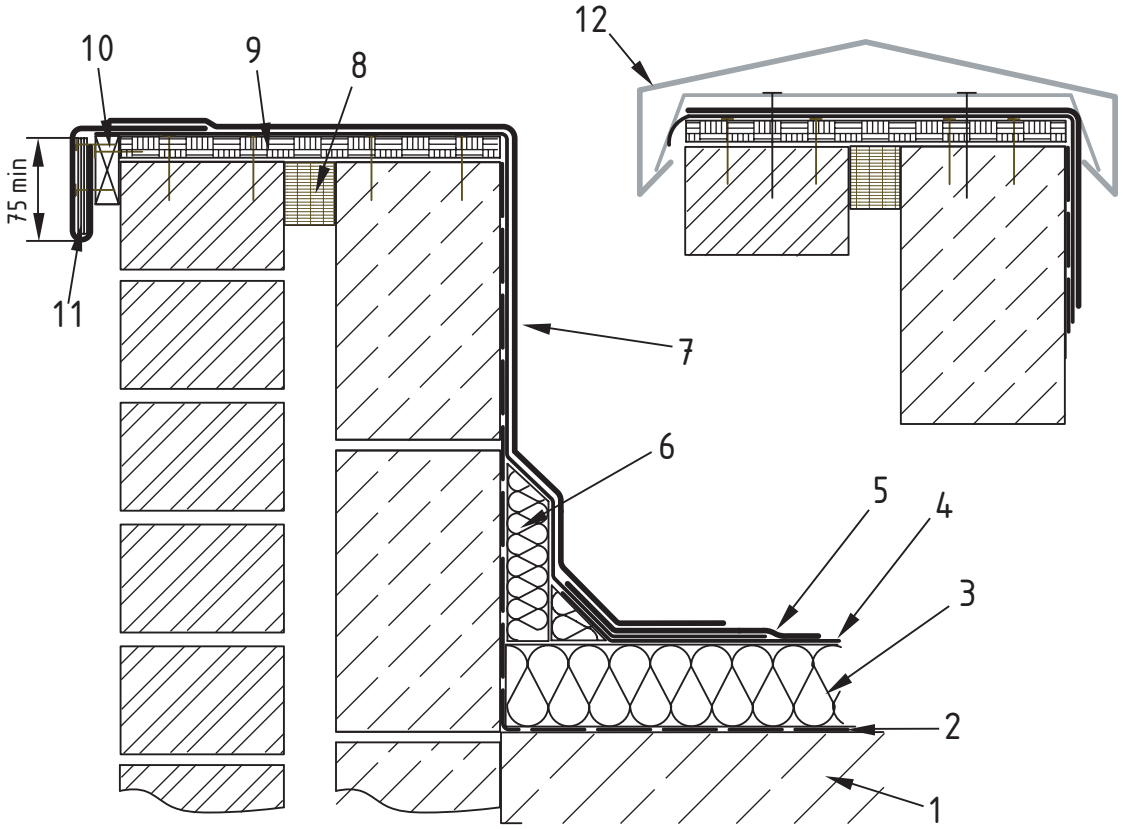

Key

1 Substrate
2 Vapour control layer (VCL)
3 Insulation
4 Underlay
5 Capsheet
6 Kerb insulation per robust details, to satisfy Part L of the Building Regulations
7 Dress membranes to encapsulate parapet
8 Non-flammable, compressible insulation
9 OSB3 or plywood capping
10 Drip batten
11 Optional plywood former
12 Alternative pre-formed capping, brackets fixed through felts.

NOTE 1 For tall upstands, see **7.4.2** regarding mechanical fixings.

NOTE 2 DPC not shown.

Figure 16 — Parapet wall with coping detail

8 Sitework

8.1 Equipment

The equipment for the installation of reinforced bitumen membrane roofing should be selected to suit the method of application, from the following.

a) *Bitumen boilers*, should be thermostatically controlled. Alternatively, if a manually controlled boiler is adopted, the bitumen temperature should be monitored with a standard calibrated thermometer.

Thermostats and/or thermometers should be regularly checked for accuracy.

b) *Gas burners*, used for heating bitumen boilers should be connected to the gas supply by flexible armoured hose with crimped connections and a regulator.

c) *Gas torches*, used for torching reinforced bitumen membrane roofing should be connected to the gas supply by flexible armoured hose with crimped connections and a regulator. Torches should incorporate a trigger valve and suitable stand.

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Single or multiple-head units should be selected to suit the system and site conditions.

d) *Bottled liquid gas fuel*, generally used for roofing burners and torches should always be used in accordance with the specific regulations for handling and storage.

e) *Bitumen pourers*, used for transporting and pouring hot bitumen should be purpose-designed, and be fitted with lids as a means of maintaining the temperature of the bitumen and as an aid to safety.

f) *Hand tools*, comprising one or more of the following to suit the type of application.

Broad-bladed scraper, trimming knife with hook blades, mop, brushes, squeegee, hammer, screwdriver, straight edge, square, marker pens, chalk line marker and gas spanner.

8.2 Safety equipment

It is essential that the following safety equipment be provided as a minimum:

a) *fire extinguishers*;

b) *protective clothing*, including gloves, footwear and hardhats;

c) *first aid equipment*.

NOTE Attention is drawn to current recommendations and statutory requirements.

8.3 Documentation and preparation

Full documentation should be prepared and there should be a full exchange of information (see Clause **4**) before work begins on site. Before the laying of reinforced bitumen membrane roofing is commenced, the contract drawings and specification, all relevant codes of practice and manufacturer's instructions for all materials being used on the project should have been studied and understood.

Any queries should be resolved before roofing begins. Clear instructions on all aspects of the work involved should be given to the workmen.

Before roofing work begins, all necessary scaffolding should be in position together with hoisting facilities. It is particularly important that all roofs are provided with safety rails and all openings are adequately protected for the safety of workmen and the public.

The deck should be in an adequate condition to receive the roofing (see **8.10**) and all necessary builder's work should have been completed.

Only sufficient materials for the day's requirements should be taken out of store and placed convenient to the area being worked. They should only be unwrapped immediately prior to use and all wrapping materials should be disposed of carefully.

Tools and equipment should be available as close as is practicable to the area being worked. This is particularly important with bitumen boilers, as it ensures that molten bonding compound is transported the minimum distance, thereby improving safety and reducing the loss of temperature between boiler and application.

Fuel bottles should be remote from the bitumen boiler, and fire extinguishers should be readily to hand wherever burners and torches are in use.

NOTE Powder, foam and CO_2 extinguishers are suitable for these circumstances.

WARNING Do not use water extinguishers on any bitumen fire.

8.4 Receiving and checking materials

Materials delivered to site should be checked for:

a) compliance with delivery note;

b) conformity to the manufacturer's supply, and correct labelling;

c) conformance with the roofing specification; and

d) quantities sufficient for the work in hand.

Non-conformities should be noted, referred to suppliers, and arrangements made to remove them from site.

When required, representative samples of materials should be retained for testing.

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8.5 Storing equipment and materials

Materials for reinforced bitumen membrane roofing should be stored carefully on clean dry level surfaces, under cover and clear of the ground. The same protection should be given to materials temporarily kept outdoors or on the roof during construction.

If materials become wet during storage, they should be dried fully before construction, or rejected.

Wetted materials that are susceptible to weakening, distortion or damage should always be replaced.

Specific manufacturer's recommendations should be followed for storage.

Board materials should be supported so as to avoid distortion and mechanical damage.

Roll materials should normally be stored on end. Some proprietary self-adhesive products might have specific storage requirements.

Materials should be taken to the roof as required for use. The load-bearing capacity of the roof should be checked if material is to be stored at roof level.

8.6 Planning and setting out the work

All preliminary work including alterations to detail items should be fully completed and satisfactory.

Outlets and apertures should be protected from ingress of debris; protection to outlets should be removed during non-operating periods.

Any retained components of an existing structure should be verified as sound and capable of accepting the imposed loading of the new system and associated installation procedures.

At the pre-tender roof inspection stage, the roofing contractor should allow for the extent, volume and degree of difficulty in stripping and carting away from site existing waterproofing and insulating materials. Particular care should be taken with any hazardous waste material.

To ensure economy of materials and good appearance of the finished work, the roofer should first set out each area of roofing. Account should be taken of the requirement to lap successive layers, the direction of fall and any physical features on the roof which will affect the pattern of laying.

The programme of work should be geared to allow the full roofing specification to be laid to a given area in a single operation; the practice of relying upon the underlay(s) in a multi-layer system to provide longer-term temporary waterproof covering should be avoided.

When stripping old materials, the area should be limited to that which can be fully waterproofed before the onset of inclement weather or nightfall.

In all refurbishment works, and ideally in all new-build projects, water ingress is not acceptable, and should be prevented by whatever means. The interior and/or occupants should be protected from hazard or damage from water.

Bitumen ingress via panel or board joints should also be prevented (see **7.3.2.4**)

Where practicable overlap joints in cap sheets should be made so as not to be opposed to the flow of water. To minimize traffic over areas of completed work, access should be planned near the highest point of the roof. On large roofs it might be advantageous to move the access point as work progresses.

8.7 Achieving the required standard of work

To achieve the required standard of roofing work, steps should be taken to ensure that:

a) design and specification decisions are taken, recorded, and transmitted to the roofing contractor before roofing work begins;

b) the design intentions are understood and achievable in the given circumstances;

c) reinforced bitumen membrane roofing is only applied by trained operatives, who have detailed knowledge of the work to be done, know who is responsible for each aspect of the work and are competent to undertake this;

d) operatives are provided with suitable equipment, specialist or otherwise, suitable for the type of system and/or application requirement;

e) the work is supervised and regularly monitored to assure compliance.

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8.8 Working conditions

Reinforced bitumen membrane roofing should not be laid in frost, rain, snow, high winds or in extremes of temperature. For cold applied systems, the manufacturer's guidelines should be followed.

Successive roof layers should be laid with the minimum of delay, to avoid trapping water during construction.

If it is required that work should proceed unaffected by weather conditions, a temporary roof with sufficient working headroom should be installed over the roof to be constructed.

Consideration should be given to the problems of entrapped moisture, as described in **6.7**.

8.9 Night joints

The works should be planned so that, at the end of works each day, or earlier if adverse weather develops, a "night joint" can be formed to seal off the completed (or part-completed) areas and prevent water ingress. A strip of robust bitumen membrane roofing should be dressed over and sealed onto new and old sections along the full working edge.

8.10 Preparing and priming decks and substrates

Any substrate to receive reinforced bitumen membrane roofing should be dry, even, free of dust, debris, laitance, grease, projecting nail heads, mortar snots, holes or sharp arrises.

Where priming is recommended to achieve a strong bond (see **5.1**) the primer coat should be applied by brushing, rolling or spraying as appropriate. It should always provide even, full cover of the background.

It is essential that all volatiles in the priming coat are allowed to dry off before applying the next layer.

Special primers can be required for self-adhesive membranes. The manufacturer's recommendations should be followed.

8.11 Installing rainwater outlets (RWOs)

In all instances, the roof outlet body should be let into the roof surface so that the top surface of the outlet flange is slightly below the adjacent roof surface. This will allow the waterproofing membrane to be dressed into the outlet in such a manner as to avoid any check to the flow of water into the outlet.

Rainwater outlets should always be fitted into and firmly fastened to the roof decking to prevent differential movement between the outlet and the bitumen membrane roofing. The bonding face should be primed for maximum adhesion. Consideration should be given to the use of an under-deck clamp. In its turn, this clamp can be fixed to the underside of the roof if it is deemed desirable.

When casting into in situ concrete, the outlet should be firmly and accurately located in its final position, and the complete upper surface should be protected from concrete spillage.

When using a threaded outlet, the spigot should be screwed into the body prior to the installation, using a suitable sealant to ensure the joint is watertight.

With a metal deck or timber-decked roof, it is advisable that a pre-formed bearing pan (plate) be used to enable the roof outlet to be supported and fixed to the deck. Thus the load will be transferred over a large area of roof decking. If this is not practicable, then the aperture for the outlet should be as small/snug as possible, and the full set of fixing screws used to retain it in position.

In all instances it is recommended that, wherever possible, the roof outlet body be let into the roof structure until the top surface of the outlet flange is flush with, or sub-flush (below) the roof surface level, prior to the installation of the waterproofing.

If it is not practical to fix the outlet dome or grating at the time of installation, the outlet should be temporarily covered so as to prevent debris from entering the downpipe.

8.12 Laying the vapour control layer (VCL)

Whenever a vapour control layer is specified, the roofer should ensure its integrity, with any damage made good before the insulation boards are applied. Bitumen membrane vapour control layers should have a minimum 75 mm of bitumen sealed side and end laps. Other VCL materials should be laid to the manufacturer's instructions.

The vapour control layer should enclose and encapsulate all edges of insulation at perimeters and at all detail work (see Figure 4).

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8.13 Laying insulation boards

The roofing contractor will be responsible for the installation of insulation boards in warm deck roofs.

Boards should be laid with staggered joints, ensuring all edges are supported and closely butted. For insulation which is to be laid where the deck is profiled metal, the board manufacturer's recommendations should be followed. A treated timber "hard edge" or similar protection should be incorporated at all exposed insulation edges to prevent crushing under traffic. This should be of reduced thickness to prevent water checks, and at changes in level the outer edge should be chamfered.

The layout of insulation boards should be carefully planned. Layout drawings for any tapered insulation scheme should be closely followed.

When mechanically fixing insulation, the type, number, and frequency of fixings should be provided in accordance with the design requirements.

Proprietary torch-on (applied) insulation boards should be fixed in accordance with the manufacturer's instructions.

Cold adhesives used to bond roof insulation should be compatible with the insulation and be laid in accordance with manufacturers' instructions.

Hot bitumen application should be full bonding. Bitumen temperatures should be sufficient to ensure bonding, without causing damage to the insulation board.

8.14 Application of reinforced bitumen membrane waterproofing

8.14.1 *General*

Before the works proceed, the contractor should ensure that the surfaces to receive the waterproofing are acceptable and that the specification conforms to the requirements. Attention is also drawn to all relevant Health and Safety Executive requirements, and any additional requirements for working procedures specified.

8.14.2 *Hot bitumen bond*

Full bonding of reinforced bitumen membrane roofing is achieved by pouring hot bonding compound onto the substrate and then unrolling the membrane into it.

The full work sequence should be as follows.

a) Roll the reinforced bitumen membrane roofing into position and cut to length.

b) Roll back the bitumen membrane roofing for a portion of its length (approximately 50 %).

c) Pour hot bonding compound onto the substrate just in front of the roll.

d) Immediately unroll the bitumen membrane roofing into the hot bonding compound, applying sufficient pressure to ensure an even spread of compound. There should be sufficient bonding compound to ensure that a small quantity squeezes out at each edge of the roll.

e) Use a broad-bladed scraper to spread out the excess compound at the edges of the bitumen membrane.

f) Roll back the other portion of the length and repeat steps c) to e).

This method of application requires the use of approximately 1.5 kg of compound per square metre of roof per layer, the exact amount varying according to the substrate.

8.14.3 *Torch application*

Full bonding of reinforced bitumen membrane roofing by torching techniques is achieved by reactivating the coating on the underside of the membrane with a gas torch. Most products have a heat dispersible film on the underside that melts during application. The sequence of work should be as follows.

a) Roll the reinforced bitumen membrane into position and cut to length.

b) Roll back the membrane for a portion of the length (approximately 50 %).

c) Heat activate by torching in the vee area between the roll and substrate. Heated coating should flow down the front of the roll to provide a continuous bead of molten coating across the full width of the membrane. The roll should be moved along with a downward pressure exuding a molten bead from the edges.

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d) The roll can be pushed forward by hand, or drawn along with the aid of a roll bar.

e) Roll back the remainder of the roll and repeat step c).

8.14.4 *Cold applied adhesive*

Cold bonding of reinforced bitumen membrane roofing is achieved by applying cold bonding agent to the substrate and then unrolling the bitumen membrane into it. The full work sequence should be as follows.

a) Roll the reinforced bitumen membrane into position and cut to length.

b) Strike a chalk marker line around the membrane for the cold bonding agent area of application.

c) Roll back the membrane for a portion of its length (approximately 50 %).

d) Apply cold bonding agent in accordance with the supplier instructions at the recommended rate of coverage.

e) Roll the membrane into the bonding agent with a downward pressure ensuring no air entrapment.

f) Roll back the other portion of the membrane and repeat steps d) and e).

The adhesive should be spread by brush, squeegee or serrated trowel to provide a full coverage for the area of bond required.

Specialist application equipment should be used in compliance with the manufacturer's instructions.

8.14.5 *Self-adhesive application*

Full bonding of self-adhesive reinforced bitumen membrane roofing is achieved by removal of the backing release film while unreeling the membrane onto the substrate. The full work sequence should be as follows.

a) Roll the bitumen membrane into position and cut to length.

b) Roll back the membrane for a portion of its length (approximately 50 %).

c) Carefully cut across the backing release film and peel the film off the roll.

d) Peel the leading edge of the backing film up and tuck it under the roll to enable release of the remainder when unreeling.

e) Roll the membrane forward, pressing downward and outward, ensuring that no air pockets are trapped.

f) Roll back the other portion of the membrane to the leading edge of release film.

g) Peel the remainder of the film away while pushing the roll forward, pressing downward and outward, ensuring that no air pockets are trapped.

h) On completion, use a soft broom or roller to apply pressure over the total area.

8.14.6 *Mechanical fastening*

Mechanical fastening of reinforced bitumen membrane roofing is achieved by using a stress plate and screw fastener applied through the bitumen membrane (and insulation and VCL if included) into the substrate.

Layout of the membranes will depend on the type of system, type of deck and fixing requirement.

Manufacturers' specifications will dictate the sequence of application.

8.15 Attachment of membranes

8.15.1 *Nailing (first layer only)*

Usually specified for securing the first layer onto timber boarding, and occasionally to plywood or OSB, subject to adequacy of thickness.

Underlay should be unrolled into position, aligned and cut to length.

Use one or two nails to hold material in position. Then working from one end using the specified nails, (usually large-headed galvanized clout nails) nail the membrane at the specified cross centres [see **7.3.4**d)].

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8.15.2 *Partial bonding — Pour and roll*

A BS 747:2000, type 3G perforated bitumen membrane should be used in hot pour-and-roll applications. Work should proceed as follows.

a) Unroll material into position, granule-side down, align and cut to length. Overlap the long edges by a minimum of 50 mm and butt the end joints.

b) Temporarily load the reinforced bitumen membrane to keep it in position. Lay the intermediate layer of the system in a flood coat of bitumen so that the bitumen passes through the perforations in the underlayer giving a regular and uniform partial bond onto the deck or substrate.

8.15.3 *Partial bonding — Torch application*

Partial bonding by torch application is usually achieved in a similar manner to pour-and-roll, but with proprietary perforated torch-receivable underlayers. It can also be created using a torchable underlay designed with specific partial bonding areas.

8.15.4 *Strip or spot bond*

Partial bonding by strip or spot bonding can be used for hot pour and roll, torching or cold adhesive applications. Work should proceed as follows for strip bonding.

a) Unroll the membrane into position, align and cut to length.

b) Roll back the end of the membrane and apply the bonding agent to the deck in strips.

c) Unroll the membrane into the bonding agent, applying pressure to ensure even spread and bond.

d) Repeat to remainder of the roll and then seal the overlap.

Work should proceed as follows for spot bonding.

a) Unroll the membrane into position, align and cut to length.

b) Roll back part of the membrane, and torch the heat-dispersible film to remove in a spot formation while progressively rolling forward the roll.

c) Repeat for the remainder of the roll and seal the overlap.

8.16 Lap joints

Lap joints in reinforced bitumen membrane roofing should generally be not less than 75 mm or as recommended by the specification and should be fully sealed.

In multi-layer systems, successive lengths of membrane should be laid in the same direction but with offset between layers to avoid excessive build up of thickness at side laps and head laps (see Figure 17).

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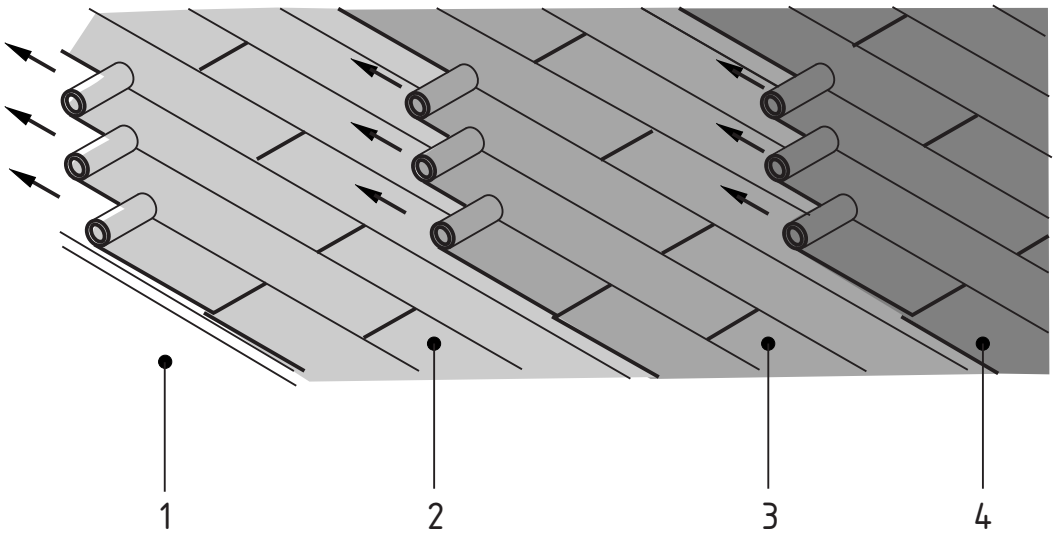

Key

1 Prepared deck
2 Specified preparation layer
3 Underlayer
4 Top layer/capsheet

Figure 17 — Multi-layer lapping

8.17 Lap joint finishes in cap sheets

8.17.1 *General*

Mineral-surfaced membranes will usually have a defined overlap selvedge along one long edge. For complete lap joint security the following finishing methods should be employed.

a) At head laps or where detailing requires a bond onto the mineral-finished surface, brush the area clear of debris or loose granules.

b) Heat the lap area and press and bed the granules in, to provide a bitumen-to-bitumen ("black-to-black") joint and ensure a full bond.

NOTE Failure to ensure a full seal can lead to capillary ingress of water.

8.17.2 *Hot bitumen*

Hot bitumen applications generally require a clean lap finish. This can be achieved by brushing a de-bonding agent along the adjoining membrane, adjacent to the selvedge, prior to installation of the hot bitumen.

Surplus bitumen spilling onto this area can be removed on cooling by trimming and peeling the excess bitumen from the lap. Care should be taken to ensure that no release agent gets under the lap and that the membrane is not damaged when trimming off the surplus bitumen.

WARNING Do not put trimmed bitumen, which might be wet, back into the hot bitumen boiler.

8.17.3 *Torching*

In torching application it is not practical to achieve clean lap finishes. With good control of the bitumen flow at lap joints a neat bead of coating should exude along each lap joint and be left in situ. If required, this can be tidied up by the immediate addition of surplus granules.

Hot-air guns can also be used to seal some proprietary bituminous membrane systems. The methods and final lap appearance will be the same.

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8.17.4 *Cold adhesive*

Adhesive should be spread over the lap area of bond in accordance with the manufacturer's fixing instructions. Note that some adhesives require an "open" time before the membrane is set into it. Only sufficient adhesive should be applied to a manageable area.

8.17.5 *Self-adhesive*

Self-adhesive applications should follow the manufacturer's recommendations.

Generally, a defined selvedge along one long side will have a self-adhesive coating which will have a release film (paper) to be removed once the membrane is aligned.

Lap joints should be rolled with a heavy roller for complete security.

End lap application will require special attention in self-adhesive systems.

It is imperative that the manufacturer's recommendations are followed.

8.17.6 *Mechanically fixed applications*

Generally, the laps in mechanically fixed systems are torched or hot-air sealed. This is covered in **8.17.3**.

8.18 Laying on slopes and vertical surfaces

The work sequence for each layer should be as described in **8.14.2** onwards, starting from the bottom of the slope. All sloping work, and all vertical work should be mechanically fixed in accordance with the specification (also as described in **7.4.1**).

Special care is required in setting out laps, in order to ensure that they coincide with fixing provisions.

Additionally, upstands higher than 250 mm should be mechanically fixed along their upper edge.

When forming reinforced bitumen membrane roofing to sloping roofs, successive layers should be carried up the slope and over the ridge before nailing to provide additional security against slippage.

8.19 Applying surface protection

8.19.1 *General*

Where the specification requires surface protection, this should be applied as soon as the reinforced bitumen membrane roofing is completed. The practice of returning to apply the protection after other trades have completed their work should be avoided.

Surface protection can consist of stone aggregate in dressing compound, pre-cast concrete paving slabs, proprietary walkway tiles in bonding compound, insulation and ballast, or insulation with an integral topping.

Before applying a bonded surface protection the roof surface should be completely dry and free from dirt. Work should proceed as described in **8.19.2**, **8.19.3**, **8.19.4** and **8.19.5**.

Care should be taken not to exceed the limitations on roof loading [see 4h)].

8.19.2 *Stone aggregate in gritting solution*

Working away from the low point of the roof towards the access point, gritting solution should be poured and spread onto the top layer at the specified rate, i.e. working backwards to minimize traffic over the aggregate. Gravel guards should be in place on all roof outlets before ballast is laid.

Aggregate should be scattered onto the solution at the rate necessary to provide complete cover (usually 16 kg/m^2).

8.19.3 *Pre-cast concrete paving flags*

Paving flags should be set out to minimize cutting.

Slabs should be laid in a forward direction, working outwards from the roof access point to minimize trafficking on the unprotected membrane.

Slabs should be laid on specified corner supports, or in bonding compound. They should not be tightly butted to perimeter upstands, instead a minimum gap of 75 mm should be allowed and filled with rounded gravel or ballast. When laid on corner supports, slabs should be carefully levelled to ensure full contact at all four corners and to prevent the slabs rocking under foot traffic.

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8.19.4 *Proprietary walkway tiles in bonding compound*

Tiling should be set out to minimize cutting. If recommended by the tile manufacturer, bitumen primer should be applied to the underside of tiles and allowed to dry.

Bonding compound or proprietary adhesive should be spread on to the roof surface in accordance with the manufacturer's instructions, and tiles should be pressed into place; squeezing excess compound between tiles at the joints should be avoided. An expansion gap should be left between tiles as recommended by the manufacturer.

8.19.5 *Insulation and ballast (inverted warm deck roofs)*

Insulation boards should be set out to minimize cutting. Small cut pieces at the perimeter should be avoided. Boards should be laid closely butted and with staggered joints.

Starting from the access point, the boards should be laid in a forward direction.

Filter fabric should be laid where specified.

Gravel guards should be in place on all roof outlets before ballast is laid.

Gauge boards should be placed to match the specified depth and ballast should be spread between them. The correct depth of ballast should then be levelled off with a straight edge and the gauge boards moved on.

8.20 Additions and alterations after completion

Any additions or alterations after completion which might compromise the integrity of the waterproofing system (and any applicable warranties) should be undertaken, where possible, by the original installer.

All repairs should therefore be carried out in materials, and with accessories and standards of workmanship, compatible with the original installation (see also **10.3**).

9 Inspection, testing and protection

9.1 Inspection and testing

During and after completion of construction, inspections, and testing if required, should be carried out to ensure that the recommendations set out in this code have been observed.

Rainwater goods should be tested prior to commencement of work, and again upon completion of the work.

9.2 Protection from following trades

As soon as an area of reinforced bitumen membrane roofing has been completed, it should be inspected, passed, and then fenced off or protected from damage from following trades. This is commonly in the form of plywood or OSB sheets laid over the surface, sometimes in conjunction with heavy gauge polythene and insulation boards. Care should be taken not to mark or dent the capsheet while laying this protection.

10 Maintenance and repair

10.1 Introduction

A reinforced bitumen membrane roof, which has been designed and installed in accordance with the recommendations of this British Standard should be capable of providing trouble-free service for many years, provided it is properly maintained.

BS 6229:2003 gives guidance on the content of maintenance manuals and the scope and frequency of routine maintenance inspections applicable to all flat roofing. All roofs should be inspected at least once each year. Ideally, there should be inspections each spring and autumn, to enable the effects of annual extremes of weather to be checked. Roofs exposed to high levels of pollution or in close proximity to trees might require more frequent inspection.

Any inspection of a roof should include the interior of the building for signs of water penetration or condensation and for alterations, which might have affected the roof. Externally, abutting construction, which can affect the performance of the roof, should also be inspected.

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10.2 Checklist for reinforced bitumen membrane roof inspection

Regular maintenance inspections should be in the form of a systematic check of the whole roof to record items which require attention. In addition to the more general guidance given in BS 6229:2003, the following checklist is applicable to reinforced bitumen membrane roofs.

a) Surface:

1) bare patches in solar reflective finish or chippings;

2) accumulation of loose chippings;

3) accumulation of silt or vegetation;

4) loose, inadequately supported or broken paving slabs;

5) exposed insulation (protected membrane roofs);

6) areas of ponding.

b) Membrane:

1) blistering, ripples, rucking, detachment;

2) cracks, splits, tears, punctures, indentations;

3) pimpling, pitting, crocodiling;

4) pulled, unbonded laps;

5) softening of surface.

NOTE In the case of roofs in which the membrane is concealed, for example by a thick layer of chippings or protected membrane design roofs and garden roofs, the general area of membrane and the substrate will not be amenable to routine inspection.

c) Substrate:

1) depressions in surface;

2) lack of support/soft support to membrane.

d) Rainwater outlets:

1) blocked;

2) not bonded to membrane (if bonded type);

3) clamping ring loose (if clamped type).

e) Upstands:

1) damaged/detached flashings;

2) sagging membrane;

3) splits, cracks, tears;

4) membrane unsupported at fillet;

5) unbonded laps;

6) blistering.

f) Eaves/verge:

1) unbonded or peeling membrane;

2) cracking/splitting or strain in membrane;

3) displacement or signs of movement of edge trim.

g) Movement joints, upstand type:

1) unsealed capping joints;

2) dislodged flashing/capping;

3) unbonded laps.

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Movement joints, proprietary flush type:

4) unbonded laps;

5) splits, cracks, tears.

h) Abutting construction:

1) parapet copings cracked, loose, unsealed;

2) damaged damp-proof course, lack of continuity in damp-proofing;

3) open joints, cracking in construction;

4) loose/missing pointing.

i) Roof fixtures and penetrations:

1) upstand defects as above;

2) rooflight glazing defects;

3) damaged/missing flashings;

4) balustrade/vent pipe, loose or missing flashing or collar;

5) plant plinth damaged/missing flashing;

6) lightning conductor tape, fixing loose/detached/missing.

10.3 Repair procedures

Repairs should only be carried out after the type and extent of any defects have been noted and their underlying cause identified. The intention of repair work should be to restore the roofing to its original condition and ensure its continuing performance. All repairs should therefore be carried out in materials, and with accessories and standards of workmanship, compatible with the original installation.

Any surface protection which has been misplaced should be made good so that the whole of the waterproof membrane is covered.

Loose flashings should be adequately secured and any defective pointing made good.

Areas of upstand which are detached should be repaired, re-adhered with hot bitumen or as appropriate and, if necessary, protected by the provision of an additional capsheet.

Any defects at penetrations should be carefully cut out, the area thoroughly cleaned and primed and a new seal formed between the membrane roofing and the penetration.

Where a movement of edge trims has caused stress failure of the reinforced bitumen membrane roofing, the covering should be removed. The ends of the edge trim should be checked to ensure they are adequately secured to the substrate in accordance with the manufacturer's instructions, and the membrane roofing should then be replaced. A strip of bitumen membrane conforming to at least type 5U should first be placed across the joint to form a slip plane.

Blisters should generally be left undisturbed, but if they contain water or are causing distress to the membrane, they should be cut open and re-bonded and a patch to the full width of the membrane roll bonded over.

All silting, debris and plant life should be removed and the whole of the roof left clean. In areas of algal or moss growth, it might be advantageous to apply a compatible water-based fungicidal wash.

On completion of all necessary repair work the roof should be re-inspected and the nature and extent of repair works recorded.

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Annex A (normative)
Methods of attachment of reinforced bitumen membrane roofing and surface protection

A.1 Hot roll-and-pour and torch-on methods of application

Table A.1 — Hot roll-and-pour and torch-on methods of application

Roofs up to and including 5° slope			
Substrate	**Method of attachment of first layer of reinforced bitumen membranes**	**Wind load** kN/m²	
		12.5 mm stone/spa chippings	**Coloured, self-finished mineral granules**
Plywood, OSB, concrete, wood wool slabs, screeds, composite roof-decks, and rigid urethane foam (RUF)	Partial bond	Up to 3.6	Up to 2.4
Cork, mineral fibre (high laminar strength grade)	Full bond	Up to 3.6	Up to 3.6
Perlite	Full bond	Up to 2.4	Up to 1.5
	Full bond and mechanically fix through first layer of high performance polyester bitumen membrane.	Up to 3.6	Up to 3.6
Timber boarding and tongue and groove decks	First layer high performance polyester bitumen membrane. Nailed at 150 mm centres	Up to 3.6	Up to 2.4
	First layer high performance polyester bitumen membrane nailed at 200 mm centres	Up to 2.4	Not acceptable
Roofs over 5° slope			
Wood wool slabs, concrete, screeds, composite roof-decks, rigid urethane foam	Overlay with bonded wood fibre board, cork or similar to allow a full bond of the first layer	Not applicable	Up to 3.6
Cork, wood fibre board, and mineral fibre (high laminar strength grade)	Full bond	Not applicable	Up to 3.6
Perlite	Full bond	Not applicable	Up to 1.5
	Full bond and mechanically fix through first layer of high performance polyester bitumen membrane	Not applicable	Up to 3.6
Timber boarding, OSB, plywood and tongue and groove.	First layer high performance polyester bitumen membrane nailed at 150 mm centres	Not applicable	Up to 2.4
NOTE See **7.4.1** for head nailing of roofs over 5° slope.			

Where the substrate is of a type requiring a partial bond, for hot roll and pour systems, the first layer of reinforced bitumen membrane should conform to type 3G of BS 747:2000. For torch-on systems, a proprietary partial bonding membrane designed for such application should be used.

Where wind loads exceed those given in Table A.1 specialist advice should be sought. Where the substrate is of a type normally requiring a partial bond, the partial bond layer may be omitted and an insulating board such as cork or fibreboard or a similar board suitable for torch-on applications, may be overlaid to provide a surface for accepting a full bond. The wind load for a full bond specification then applies.

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A.2 Cold adhesion method of application

There are several cold application systems available such as bitumen solutions, contact adhesives, mastic adhesives, polyurethane adhesives, and self-adhesive systems. In general, bitumen contact and mastic adhesives along with polyurethane adhesives are regarded as providing partial-bond systems only. Similarly, bitumen solutions and self-adhesive systems are regarded as full-bond applications.

In all cases, a wind uplift calculation should be undertaken.

If the result is greater than 2.4 kN/m^2, the system manufacturer should confirm that the values are achievable with the complete proposed system.

Table A.2 — Cold adhesion method of application

Roofs up to and including 5° slope			
Substrate	**Method of attachment of first layer of reinforced bitumen membrane and type of adhesive used**	**Wind load** kN/m^2	
		12.5 mm stone/spa chippings	**Coloured, self-finished mineral granules**
Plywood, OSB concrete, wood wool slabs, screeds, composite roof-decks, and rigid polyurethane foam	Partial bond — bituminous mastics and polyurethane adhesives[a]	Up to 3.6	Up to 2.4
Cork, mineral fibre (high laminar strength grade), plywood, OSB and composite roof decks, rigid polyurethane foam	Full bond — self-adhesive bitumen membranes and bituminous solutions	Up to 3.6	Up to 3.6
Perlite using self-adhesive bitumen membranes and bituminous solutions	Full bond	Up to 2.4	Up to 1.5
	Full bond and mechanically fix through first layer of high performance polyester bitumen membrane.	Up to 3.6	Up to 3.6
Timber boarding and tongue and groove decks — either cold system may be used over the first layer, which is always nailed	First layer of high performance polyester bitumen membrane, nailed at 200 mm centres	Up to 2.4	Not acceptable
	First layer of high performance polyester bitumen membrane nailed at 150 mm centres	Up to 3.6	Up to 2.4
Roofs over 5° slope			
For applications over 5°, the use of a 12.5 mm layer of chippings is not applicable. Otherwise, partial bond systems using bituminous mastics and polyurethane adhesives may be used for sloping roofs.			
[a] In order to achieve these figures for polyurethane adhesives, it is essential that they are applied strictly in accordance with the manufacturer's instructions.			
NOTE 1 The partial bond is formed when using bituminous mastics and polyurethane adhesives by releasing the material in strips or in an "S" or frame pattern, in order to give a bond area of about 10 % — the equivalent to that of a type 3G bitumen membrane of BS 747:2000.			
NOTE 2 See **7.4.1** for head nailing of roofs in excess of 5° slope.			

Where wind loads exceed those given in Table A.2 specialist advice should be sought.

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A.3 Attachment of vapour control layers

Table A.3 — Attachment of vapour control layers

Substrate	Method of attachment of vapour control layer	Wind load kN/m²	
		12.5 mm stone/spa chippings	Coloured, self-finished mineral granules
Concrete (heated and high humidity buildings), screeds and composite roof decks	Partial bond	Up to 3.6	Up to 2.4
Concrete (unheated buildings),	Full bond	Up to 3.6	Up to 3.6
Plywood, OSB	Full bond (with taped joints)	Up to 3.6	Up to 3.6
Timber boarding and tongue and groove decks	First layer high performance polyester bitumen membrane. Nailed at 150 mm centres.	Up to 3.6	Up to 2.4
	First layer high performance polyester bitumen membrane. Nailed at 200 mm centres.	Up to 2.4	Not acceptable
Profiled metal[a] [b]	Bonded to primed crowns with no additional mechanical fixings	Up to 3.6 with 25 mm chippings	Up to 2.4
	Bonded to primed crowns with at least three additional mechanical fixings per m^2	Up to 3.6	Up to 3.6
	Bonded to suitable thin insulation or board which has been mechanically fastened to deck with at least nine fixings per m^2	Up to 3.6	Up to 3.6
NOTE See **7.4.1** for further advice on roofs over 5° slope.			

[a] Wind load calculations should be carried out where systems are mechanically fastened onto profiled metal decks.
[b] Ensure that the area of crown available on the particular profile used can provide sufficient bond area to achieve the required wind uplift.

Where the substrate is of a type requiring a partial bond, for hot roll and pour systems, the first layer of reinforced bitumen membrane should conform to type 3G of BS 747:2000. For torch-on systems, a proprietary partial bonding sheet designed for such application should be used.

Where self-adhesive vapour control layers are used or where bonding is by a cold adhesive then the manufacturer's advice for particular wind load situations should be sought.

Where wind loads exceed those given in Table A.3 specialist advice should be sought. Where the substrate is of a type normally requiring a partial bond, the partial bond layer may be omitted and an insulating board such as cork or fibreboard or a similar board suitable for torch-on applications may be overlaid to provide a surface for accepting a full bond. The wind load for a full bond specification then applies.

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