

Reinforced bitumen membranes for roofing —

Code of practice

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Committee responsible for this British Standard

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- 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 It supersedes BS 8217:1994, which is now withdrawn.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*.

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

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

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.

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].

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.

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.

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.

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/m³ and 130 kg/m³, except where regular foot or vehicular traffic is anticipated, when higher density slabs (up to approximately 200 kg/m³) 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/m³, but the minimum density should be 110 kg/m³ 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/m³.

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.

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.

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.

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.

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.

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.