2.3 INSULATION BOARDS

INTRODUCTION

All insulants rely for their thermal efficiency on trapped air or gas to provide a resistance to the flow of heat.

Insulation foams trap the air or gas within a cellular structure. Fibrous materials trap air between the fibres and their insulation efficiency depends on the size and orientation of the fibres.

Insulation boards can be divided into four main groups:

VEGETABLE:	Wood fibreboard Cork
MINERAL:	Mineral wool Cellular glass Perlite
PLASTIC FOAMS:	Polystyrene (bead) Polystyrene (extruded) Rigid urethane Phenolic
COMPOSITE BOARDS:	Cork / urethane Perlite / urethane Perlite / phenolic Fibreboard / polystyrene

Wide ranges of insulation boards are available which incorporate proprietary refinements to the basic material or are manufactured with facings of plastic, paper, metal foil, glass fibre tissue or bituminous roofing.

A board insulant should not be chosen solely on the basis of thermal efficiency. An equally important function of the insulation is to provide firm support for the waterproofing.

The thermal and moisture movement characteristics of the insulation must be understood, and the waterproofing partially bonded or fully bonded accordingly.

Satisfactory site handling qualities should not be ignored. Unless a material can be satisfactorily handled and fixed without damage, the system may be put at risk. The desirable qualities looked for by a roofing contractor are ease of cutting, robust working surfaces which are not dusty or friable or abrasive to the touch, corners which are not susceptible to breakage and materials which do not require special techniques of application.

The following pages provide a generalised guide to the performance characteristics of the various types of insulation board available, together with application techniques for warm roofs.

WOOD FIBREBOARD

Wood fibreboard was the first type of board extensively used for roof insulation but is no longer widely used as it does not provide sufficient insulation for modern U-value requirements, and is vulnerable to decay if it becomes damp. It is used as a low cost facing material on expanded polystyrene insulation to protect the polystyrene from the heat of hot bitumen and is also used as a low cost overlay board for re-roofing.

Boards should comply with type SBI or SBS of BS 1142:1989 Specification for fibre building boards.

Moisture absorption can cause significant movement of fibreboard and may cause ridging of the waterproofing over the joints, but the movement is extremely slow and will not normally lead to a fatiguing action on the waterproofing.

Wood fibreboards have good compressive and laminar strength and a very low coefficient of thermal expansion. They provide a satisfactory base for mastic asphalt waterproofing or fully bonded built-up roofing.

CORK

A well established and proven insulation material formed from pure granulated cork, compressed, steam baked and held together by the natural cork gum.

Cork is resistant to moisture and decay and is suitable for use above high humidity conditions. It provides a substrate of good laminar and compressive strength suitable for asphalt roofing and with its low coefficient of thermal expansion will accept a full bonded built-up roofing specification.

Although cork is somewhat friable during handling, it is firm under foot traffic and is a suitable insulation to use below membranes which are subject to continual foot traffic. For general handling strength, a minimum 25mm thickness is recommended. An underlay may be required to provide support over the troughs of metal decking depending on the thickness of the cork and the trough opening of the deck.

Cork is widely used as a heat resistant and stable facing to rigid urethane insulation to form a composite insulation. Also widely used in tapered form to provide falls. In the absence of a British Standard for cork, the FRCAB information sheet No.19 gives minimum requirements for natural corkboard insulation for use with built-up roofing.

PERLITE

Perlite is a mineral of volcanic origin. It contains a small amount of water which causes powdered perlite to expand some 20 times when heated. During manufacture, the perlite is combined with mineral fibres and binders to produce a roofboard with a thermal insulation value similar to wood fibreboard but with a greatly reduced combustible content.

One surface of perlite board is usually treated during manufacture with a bitumen emulsion to increase resistance to bitumen absorption and bind the surface.

Perlite boards generally have a good compressive strength but low laminar strength. They are also rather brittle and a minimum 25mm thickness is recommended. Perlite boards resist decay but the absorption of moisture can cause significant loss of strength. They have a very low coefficient of thermal expansion and will accept fully bonded waterproofing specifications. As with wood fibreboard the dimensional stability and heat shielding qualities of perlite are often used to improve the performance of other insulants either in the form of a composite with polystyrene, rigid urethane or phenolic or as an on site overlay to these materials.

MINERAL FIBRE

Rock wool is manufactured from volcanic rock, melted at extremely high temperatures. The molten rock is directed onto a series of rotating wheels where it is converted into thin fibres and during this process a small amount of resin is added to act as a binding agent. The fibres are gathered together to form a mat, which is then cured and compressed to form a rigid insulation slab.

Mineral wool slabs provide a good level of thermal insulation and a dimensionally stable substrate with high resistance to combustion. Special roofboard qualities are available with high laminar strength, and a glass tissue facing. Only the special roofboard quality should be used for flat roofing.

CELLULAR GLASS

Cellular glass is made from pure glass, expanded during manufacture and formed into slabs which are inorganic, will not rot or decay and are non-combustible. Slabs are available in constant thicknesses or tapered to provide falls.

The slabs are almost impermeable to water vapour, will not gain moisture by vapour diffusion and can normally be laid without a vapour barrier, provided that the joints are sealed in bitumen according to the manufacturer's instructions.

Cellular glass provides a stable base for mastic asphalt and fully bonded built-up roofing.

When mastic asphalt is applied, two layers of loose-laid non-bitumenised paper are required between the slabs and the sheathing felt isolating membrane to prevent adhesion of the asphalt.

EXPANDED POLYSTYRENE

Expanded polystyrene boards, generally known as bead boards are formed by a steam heated process which expands the beads of polystyrene and fuses them into a slab.

Roofboards are available in Grades HD (High Duty) and EHD (Extra High Duty), and should conform to type A of BS 3837:Part 1:1986 Specification for boards manufactured from expandable beads. Boards are available with a pre-felted upper surface and may be of a constant thickness or tapered to provide falls. Pre-felted HD grade board, overlaid with fibreboard or perlite board is normally used for roofing applications. Expanded polystyrene boards are also available as composites with wood fibreboard or perlite board laminated to the upper surface.

Expanded polystyrene boards exhibit large thermal movement and are heat sensitive. The boards cannot tolerate the temperatures which arise from the direct application of hot bitumen or asphalt. Indirect laying techniques have to be adopted by applying a coat of hot bitumen to the substrate, and allowing it to cool to a tacky condition before the expanded polystyrene board is laid.

A wood fibreboard, perlite board or corkboard overlay performs the dual function of shielding the expanded polystyrene from hot bitumen and asphalt and absorbing the thermal movement sufficiently to permit a fully bonded built-up roofing system. The overlay should be laid to break joint with the polystyrene unless factory applied.

EXTRUDED POLYSTYRENE

Extruded polystyrene boards have similar thermal movement and heat sensitivity characteristics to expanded polystyrene but have an improved thermal conductivity. The boards are also exceptionally resistant to water absorption and are therefore normally used in the inverted roof system.

Extruded boards should comply with BS 3837:Part 2:1990 Specification for extruded boards, grade E4.

When selecting a board thickness to achieve a specific U-value for an inverted roof, it is necessary to allow for the loss in efficiency due to the effect of rainwater draining through the insulation. The normal method to take this into account is to add 20% to the thickness of the board.

Application in the protected membrane roof system consists of laying the boards loose above the waterproofing with anchorage against wind uplift and protection from ultra-violet degradation provided by a loading coat of gravel or paving slabs.

A loose laid underlay may also be applied to even out surface irregularities or, if the waterproofing has a rough or sharp surface, to prevent abrasion to the underside of the board. The manufacturers of the insulation will advise on a suitable underlay material.

The insulation can be covered with rounded gravel with the minimum size in the order of 20mm. Standard gravel gradings allow a tolerance for quarries and a proportion of fine material may be present unless expressly excluded by agreement. Fine granules can work their way through the joints of the insulation and can cause damage and instability if they accumulate on the underside of the insulation. If it is expected that significant quantities of fine gravel will be present, it will be necessary to add a filter layer on top of the insulation to act as a sieve and prevent the passage of fine material through the joints. Again the manufacturers of the insulation will advise on a suitable material.

LIGHTWEIGHT INVERTED ROOF

Interlocking extruded polystyrene panels are available with a cementitious surfacing, to provide an inverted roof which is light in weight, but can be used without additional loading. The interlock ensures safety against wind forces within limits prescribed by the manufacturers.

A special grade of panel is available with a reinforced cementitious surfacing for pedestrian terrace decks. This surface is suitable for foot traffic only.

Otherwise the panels are only intended to receive light maintenance traffic.

For both panels it is desirable to provide an even substrate, free of undulations to provide continuous support for the panels. This will reduce the risk of panel breakage under foot traffic.

The roof system must be impermeable and secure against wind. Panels must be protected from wind blowing under them. Edges against parapets and abutments should have panels set back about 50mm and infilled with clean gravel. Panel joints are set open by 1mm to allow for thermal movement. The roof waterproofing should be installed to falls to prevent significant ponding, as this could give rise to flotation of the panels, or the need for extra loading to prevent floatation.

In all cases the detail of design and application must be in accordance with the manufacturers instructions.

RIGID URETHANE FOAM

Polyurethane (pur) and polyisocyanurate (pir) type boards are foamed with an inert gas or blowing agent. This is locked into the cells and gives the boards better insulation characteristics than foams which have air-filled cells.

The blowing agent must conform to internationally agreed levels of ozone depletion potential (ODP) and some blowing agents can only be regarded as transitional until all materials are developed to contain no significant ODP.

There is no agreed definition of pur and pir type formulations but the term pir type is used to describe a rigid urethane foam with increased trimerisation. This gives a foam with increased resistance to high temperatures, sufficient to withstand the heat of mastic asphalt on application.

The cell walls are slightly permeable to air and, over a period of several years, the air will diffuse into the cells until it reaches atmospheric pressure. The thermal efficiency of the foam decreases over this period and this should be allowed for in the figures published for thermal conductivity. A suitable test for thermal conductivity of aged material is the ACERMI test from France. Manufacturers should be asked to confirm that their quoted thermal conductivity properly allows for long term ageing.

Unfaced rigid urethane foam is likely to suffer movement from changing temperature and conditions. A glass tissue facing is therefore used to control the foam and produce a stable board to receive built-up roofing and asphalt. Board for built-up roofing is normally faced with bitumen coated glass tissue for good part-bonding with type 3G roofing, and board for asphalt is faced with glass tissue only, as in this case a bond is to be avoided.

Partial bonding is not suitable for sloping roofs and a cork or fibreboard overlay should be added to allow a fully bonded system.

PHENOLIC FOAM

Phenolic foam is similar in structure to rigid urethane foams, and in the need to conform to internationally agreed ODP levels. An extremely small cell size is possible, and leads to an improved λ value. The cell walls tend to be friable, which makes the foam rather vulnerable to damage. Formulations have rapidly improved, however, and will continue to do so.

The advantage of phenolic foam is a greater resistance to high temperature than other foams, and the possibility of improved performance in a fire.

In other respects phenolic foam is similar to rigid urethane, and the first layer of a built-up roofing specification will be type 3G perforated roofing to give a part bonded attachment.

COMPOSITE INSULATIONS

Composite boards should consist of insulation products which individually are suitable for roofing. The long term bond strength between the materials should be at least as strong as the delamination strength of the weakest individual component. The composite board should be free from warping, bowing and be dimensionally stable both during application and in service.

Rigid urethane and phenolic foams are to some extent heat sensitive. They can be formulated to withstand the heat of mastic asphalt, but are much more heat resistant in composite form with a facing of cork, perlite or fibreboard. The facing is also suitable to receive a full bond of the first layer of built-up roofing, and this eliminates the need for BS 747 type 3G vented base layer to provide a partial bond. The cost saving from omitting the type 3G material can be set off against the extra cost of forming a composite and can lead to an economic overall specification with useful technical advantages.

CORK / URETHANE COMPOSITE BOARDS

A cork insulation layer can be added to rigid urethane as a facing to form a composite board. This has the advantage of offering a cork surface for the application of the waterproofing. Built up roofing can be bonded direct without the use of a vented base layer, and the cork is an ideal heat resistant surface to receive mastic asphalt.

Cork / urethane composites are frequently used cut to falls to provide a tapered insulation system.

PERLITE / URETHANE COMPOSITE BOARDS

The perlite surface allows a full bond for built-up roofing. But perlite has a relatively low laminar strength and the specification may need mechanical fixing through the first layer of roofing when a roof is exposed to high winds, in just the same way as for normal perlite boards.

PERLITE / PHENOLIC COMPOSITE BOARDS

This composite brings together two materials with improved fire characteristics, and resistance to high temperatures. Due to the low laminar strength of perlite, mechanical fixings may be required on exposed sites.

Perlite / phenolic composite is suitable for fully bonded built-up roofing, and for mastic asphalt.

FIBREBOARD / POLYSTYRENE COMPOSITE BOARDS

Expanded bead polystyrene is extremely heat sensitive and must always be overlaid with a heat resistant insulation before application of built-up roofing or mastic asphalt. The composite board combines the overlay into a single board and forms a low cost insulation suitable for full bonded built-up roofing and asphalt.

Particular care is necessary to install the composite with tight joints between boards and at abutments to prevent damage from hot bitumen penetrating the joints or radiant heat from mastic asphalt when it is applied.

Fibreboard / polystyrene composite is frequently used cut to falls in a tapered insulation roof drainage system.