17 WIND ATTACHMENT DESIGN GUIDE

INTRODUCTION

Once the design wind loads have been determined for a roof, the appropriate method of attachment of the roofing specification can be considered.

Mastic asphalt is laid unbonded to the substrate, and only the attachment of the insulation and vapour control layers need be considered.

For built-up roofing, the attachment of the waterproofing layer, the insulation and vapour control layer all need to be designed to take into account the wind loads.

The efficiency of a bitumen bond, a partial bitumen bond or the holding power of mechanical fixings can only be forecast within approximate limits. It is usual to carry out formal calculations for the attachment of insulation layers to metal deck, but the attachment of insulation to other decks and the attachment of waterproofing to insulations is normally based on experience and according to guidance given in BS 8217:1994 which gives guidance for wind loads up to 3.6kN/m².

In order to provide further guidance for designers, the following section proposes limitations on the application of flat roofing specifications for three categories of wind risk.

The first category relates to nett wind loads up to 2.4kN/m², the second category wind loads up to 3.6kN/m² all in accordance with BS 8217:1994 and the third additional category for wind loads over 3.6kN/m².

The nett wind load is the design wind load less the self weight of the waterproofing specification. For critical layers the full wind load including internal and external co-efficients should be used, and above the critical layer the external co-efficient will suffice.

The categories are notional and have been selected from experience to represent broad bands of measurement for the severity of the wind. Suggested forms of attachment and the influence of loading coats are indicated for each category of wind force, taking into account the type of roof deck and the laminar strength of the insulation.

In some cases specific product data and test results may be available to give more accurate forecasts of performance.

DELAMINATION OF INSULATION

Insulation materials exhibit different levels of resistance to delamination and it is useful to consider them in two general groups: those insulations which from experience exhibit relatively high resistance to delamination and those which exhibit a low resistance to delamination. This grouping provides an easy method of analysis and is allowed for in the tables which follow.

Typical high resistance materials are cork, wood fibreboard, rigid urethane foam board and high density mineral wool. Materials with a low resistance to delamination include low density mineral wool slabs, and perlite board. Phenolic foam boards may tend to a glass-like cell structure which could be broken down by continuous traffic after the roofing has been completed. This may weaken the bond between the foam and the facing, and if continuous traffic conditions are likely a reduced design load should be considered. For example see perlite insulation in table 1.24. Alternatively the board can be strengthened by the addition of an overlay of a stable insulation such as cork.

Low resistance boards should be used with caution, and it will sometimes prove necessary to hold them against delamination by securing them to the deck with mechanical fixings and large washers. As a generalisation, insulation boards with a low resistance to delamination should only be applied on wind impermeable decks, or with a vapour control layer which will act as the critical layer and relieve the insulation from much of the wind load. Built-up roofing specifications on these insulants will also benefit from a loading coat of stone chippings to reduce the possibility of disturbance of the waterproof covering by the wind.

TIMBER BOARDED ROOFS

BUILT-UP ROOFING NO INSULATION

Tongued and grooved timber boarding may be taken as an air impermeable deck and the small amount of air leakage to the underside of the membrane is not of great significance. The traditional nailing patterns have proved satisfactory and clearly make sufficient allowance for the air leakage through the deck. Butt jointed timber decks should not be used with built-up roofing because of warping and shrinkage.

BS 747 type 5U polyester base roofing, polyester 180 or glass/polyester roofing is normally used as the first layer of built-up roofing nailed direct to a timber deck. The frequency of nailing of this layer will depend on the nail-holding power of the felt used. Assuming that the holding power of the nail into the timber is the weakest part of the system, nails at approximately 200mm centres will prove satisfactory on the majority of sites where there is a loading coat of chippings.

For mineral surfaced roofing or in cases of exposure to wind forces exceeding 3.6kN/m² the high performance first layer should be nailed at 150mm centres.

Table 1.23 gives suggested forms of attachment suitable for given wind loads.

BUILT-UP ROOFING WITH INSULATION

When an insulation is applied to timber boarding, a vapour check or underlay will normally be required. The underlay will be nailed to the deck at 200mm centres, as above, and the insulation will be bonded in bitumen on top of it. The attachment of the waterproofing layer will depend on the type of insulation used and on the provision of loading coats as shown in table 1.24.

CONCRETE, WOODWOOL, PLYWOOD AND PARTICLEBOARD DECKS

BUILT-UP ROOFING NO INSULATION

In-situ concrete decks, precast concrete units and prescreeded woodwool slabs are generally considered to be air impermeable. The joints should be sufficiently close to prevent the free flow of air and any open joints should be filled or taped.

Plywood and particleboard decks may also be considered air impermeable provided the edges of the panels are supported on joists or noggins and those not closed off by the support system are taped.

Direct applied membranes are normally part bonded to concrete, woodwool, plywood and particleboard decks, using BS 747 type 3G perforated roofing or other part bonding systems. A bitumen based priming coat should be applied to concrete or screeded surfaces. Table 1.23 gives suggested forms of attachment for given wind loads.

BUILT-UP ROOFING WITH INSULATION

A vapour check will be fully bonded on these decks and a vapour barrier will be fully or partially bonded as indicated in the Vapour Control Design Guide. The insulation board is usually fully bonded to the preceding layer and this will suffice for all conditions of exposure. The attachment strength of the waterproofing will depend on the insulation, the method of attaching the waterproofing to the insulation, and the provision of loading coats, as shown in table 1.24.

Attachment of built-up roofing

TABLE 1.23 Built up roofing direct to deck with no insulation

Deck	Attachment of first layer	Surface protection	Wind load kN/m²
Plywood Particleboard Concrete Wood wool	Partial bond	Mineral surface roofing	up to 2.4
		Stone chippings	up to 3.6
	Overlay with insulation see Table 1.24		over 3.6
Timber	Polyester base felt nailed at 200mm centres	Mineral surface roofing	Not recommended
		Stone chippings	up to 2.4
	Polyester base felt nailed at 150mm centres	Mineral surface roofing	up to 2.4
		Stone chippings	over 3.6

TABLE 1.24 Built up roofing to insulation

Deck	Attachment of first layer	Surface protection	Wind load kN/m²
Rigid urethane foam, Phenolic foam	Partial bond	Mineral surface roofing	up to 2.4
		Stone chippings	up to 3.6
	Overlay with cork or wood fibreboard to give full bond	Stone chippings or Mineral surface roofing	over 3.6
Cork, Cellular glass. Wood fibreboard, Mineral fibre (high laminar strength)	Full bond	Stone chippings or Mineral surface roofing	over 3.6
Perlite	Full bond	Mineral surface roofing	up to 1.5
		Stone chippings	up to 2.4
	Full bond & mechanically fix through polyester felt	Stone chippings or Mineral surface roofing	over 3.6

METAL DECKING

BUILT-UP ROOFING TO INSULATION

A vapour control layer on metal deck will act as a critical layer and the waterproofing will then be fully or partially bitumen bonded to the insulation as indicated in table 1.24 according to the ability of the selected insulation board to resist wind delamination, and the influence of loading coats.

When lightweight flexible membranes are to be applied to low strength insulation and additional loading coats are not admissible, the conditions of exposure may dictate the need for the first layer waterproofing to be mechanically fastened, together with the insulation, to the deck. In this case, a high performance first layer waterproofing will be required.

ATTACHMENT OF INSULATION TO METAL DECKING

Bitumen bonding of the insulation provides the most stable base for the waterproofing membrane, and this can be supplemented by mechanical fixings if necessary. Mechanical fixings are efficient when properly selected and applied and may also prove economic compared with bitumen bonding, but the fixings are visible on the underside of the deck.

Sole reliance on mechanical fixings may be dictated by specific fire requirements in order to avoid a combustible adhesive and under these circumstances the entire specification, including underlays and insulation, must also be chosen to satisfy these requirements.

BITUMEN BONDING

The strength of a bitumen bond to the top flats of a metal decking profile is commonly taken as 2.4kN/m^2. Profiles used for metal decking are available with a range of trough spacings and widths of top flat for bitumen bonding. The allowance of 2.4kN/m^2 however, will give a good indication of performance on the majority of decks available in the UK. For wind forces exceeding 2.4kN/m^2, it may be necessary to add mechanical fixings to supplement the bitumen bond.

A satisfactory alternative to mechanical fixings is to add an extra loading coat, such as 25mm paving slabs or 25mm of chippings in place of the usual 10mm and this will be satisfactory under most conditions of exposure in the UK. Nett design uplift in the order of 3.6kN/m^2 should be appropriate.

An alternative to avoid penetrating a vapour barrier with fixings is to design for the vapour barrier to be installed at an intermediate layer in the insulation. This allows a thin base layer of insulation to be mechanically fixed. The vapour barrier is fully bonded to this base layer and the main insulation is bonded to the vapour barrier. The thickness of each layer of insulation must be chosen to ensure that the dew point is located above the vapour barrier.

MECHANICAL FIXINGS

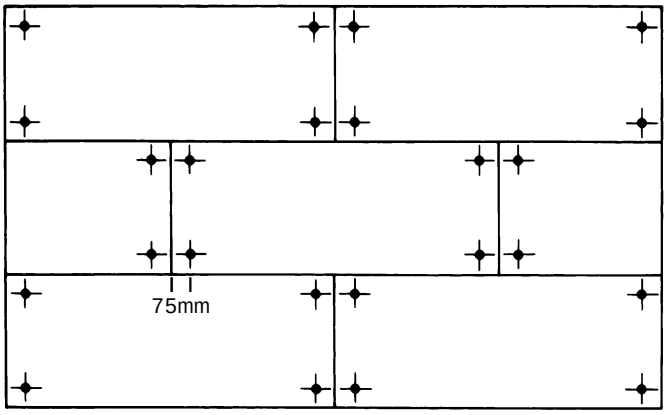
Several types of fastener systems are available for mechanically fixing insulation boards to metal decking. All use washers or discs of varying shapes but approximately the same size, in the order of 50-70mm diameter, to provide the necessary holding power.

Self-tapping, self-piercing screws are normally used into steel or aluminium decks. Fine screw threads strip easily in the thin metal of the decking and specially designed coarse thread screws are essential.

For convenience of design, it is usually best to work to one standard design strength per fixing. A conservative value of 0.4kN per fixing is recommended by the Flat Roofing Contractors Advisory Board, and BS 8217:1994.

A minimum four fixings per board placed with one fixing near each corner will ensure that every board is firmly and independently secured. When more than four fixings per board are necessary, the exact pattern is of little importance provided a regular distribution is achieved.

Fixings should be inserted not closer than 75mm from the edges of the insulation boards. The practice of inserting fixings at the joints between boards should be avoided as this results in a weakening of the board around the fixing.



Four fixings per board

Where mechanical fixings are installed after the application of a fully bonded high performance first layer, a minimum of four fixings per square metre should be used with additional fixings as necessary, depending upon the design wind load.