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May 2006

Dow - Building Solutions

Insulating inverted roofs with STYROFOAM

Insulating inverted roofs

Basic principles

The performance and longevity of flat roofs depends upon many factors, including the position of the insulation within the construction.

If insulation is placed below the structural deck (cold roof construction) the structure remains cold and there is a considerable risk of condensation; for that reason cold deck roofs are not recommended and are now seldom used.

Insulation placed above the structural deck and beneath the waterproof layer (warm roof construction) reduces the risk of condensation but, because the waterproof layer is thermally isolated from the rest of the roof construction, it is exposed to wide temperature fluctuations with consequent increased risk of premature failure (Figure 01). The inverted roof concept overcomes the problem by placing thermal insulation above the waterproof layer, maintaining it at an even temperature close to that of the building interior and protecting it from the damaging effects of UV radiation and from mechanical damage.

The insulation protects the waterproof covering from:

- wide temperature variations - +80 to -20°C.
- degradation from weathering.
- mechanical damage during construction, use and maintenance.

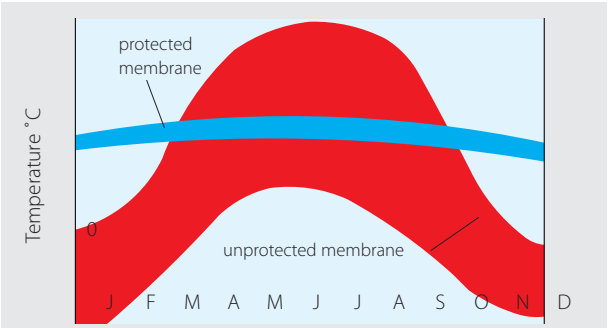


Figure 01 >> Temperature fluctuations in an unprotected roof covering compared with those in one protected by STYROFOAM

The waterproof layer acts as a total vapour control layer and, being on the warm side of the insulation, is maintained above dewpoint temperature so the risk of condensation is eliminated.

The inverted roof concept has other benefits.
The insulation can be:

- installed in any weather.
- added to, without stripping the waterproof layer.
- easily lifted and replaced/re-used if the building is altered.

The insulation for an inverted roof must:

- resist water absorption.
- be unaffected by freeze/thaw cycling.
- withstand surface traffic.
- protect the waterproof layer long term.
- be ballasted to prevent flotation.
- be protected from UV and mechanical damage.

General recommendations on the design of inverted roofs are contained in BS 6229. Agrément certificate 97/3431 contains specific recommendations regarding the use of ROOFMATE™ insulation.

Construction of the inverted roof

In the inverted roof system insulation is laid over the waterproofing layer and suitably loaded to restrain it against flotation and wind uplift and to protect it against damage.

Inverted roof constructions can be categorised as heavyweight or lightweight by reference to the form of building construction involved. If the structure incorporates a concrete slab it will normally be cost-effective to design the slab to support the load of 80 - 120 kg/m^2 imposed by a ballasted inverted roof system (Figures 02 and 03).

Insulating inverted roofs: basic principles

Dow also offer an alternative inverted roof solution to suit lightweight, long span structures, capable of supporting a minimum nominal load of 30 kg/m^2.

The lightweight inverted roof features a STYROFOAM™ board which, thanks to a bonded mortar topping and interlocking edge profile, does not require an additional ballast layer (Figure 04). This lightweight solution enables a far wider range of buildings to gain the benefits of the inverted roof system.

The inverted roof concept is ideally suited to green roofs where the roof is covered with a plant-bearing layer (Figure 05). Green roofs may be used to:

- reduce a building's environmental impact.
- provide a garden area for projects where space is at a premium.
- contribute to a building's appearance.

Roof loadings

The basic roof structure may be of concrete, metal or timber: it must be strong enough to withstand the maximum predicted loads with a suitable factor of safety.

Inverted roofs are subject to three main loads:

- dead loads: the self-weight of all the materials used: for calculation advice see BS 6399: Part 1.
- wind loads: the positive and negative pressures acting on the roof should be calculated using either the standard or directional method given in BS 6399: Part 2.
- imposed loads: see BS 6399: Part 3.

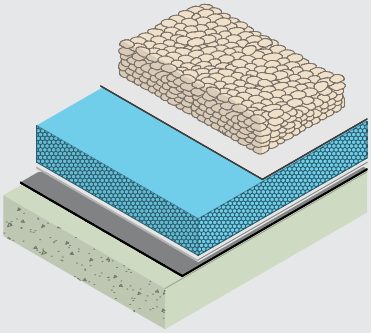


Figure 02 >> Inverted roof with aggregate ballast

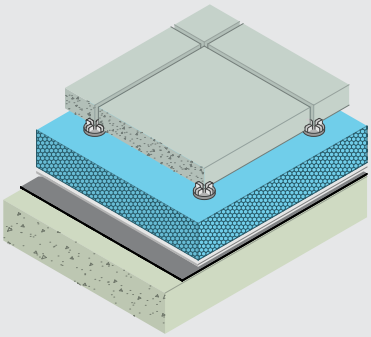


Figure 03 >> Inverted roof with paving ballast

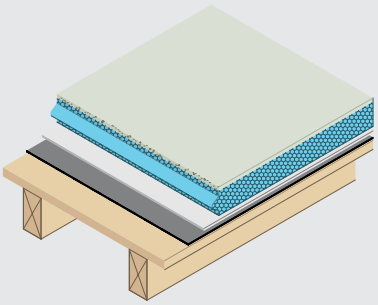


Figure 04 >> Inverted roof on light-weight deck with self-ballasted insulation

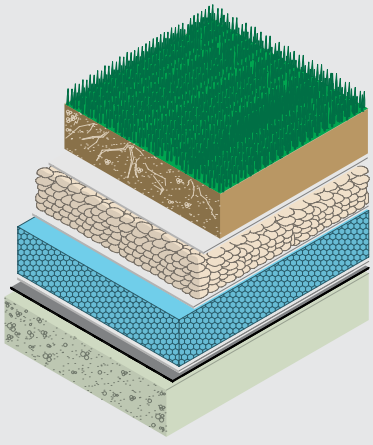


Figure 05 >> Inverted green roof

Thermal performance

Table 11 shows the thickness of insulation required to achieve the expected a range of U-values now required by Part L: 2006.

In an inverted roof construction some rainwater will run off beneath the insulation boards and in doing so may draw heat from the deck. To compensate for this intermittent heat loss it is usual to increase the thickness of insulation by 20% (rainwater cooling penalty) or if the ROOFMATE™ M^{in}K system is used this can be reduced to 2% - see page 16.

U value	0.35	0.25	0.20	0.18	0.16
Standard*	90mm	140mm	180mm	200mm	220mm
ROOFMATE M^{in}K system**	80mm	120mm	160mm	180mm	200mm

Roof build-up:
- Ballast (aggregate or paving slabs)
- Separation layer (eg. ROOFMATE MK)
- ROOFMATE SL-X
- Separation layer
- Mastic asphalt 20mm
- Sand cement screed 50mm
- Concrete deck 200mm

*20% rainwater cooling penalty
**2% rainwater cooling penalty

Table 11 Required ROOFMATE SL-X thickness to meet U-values (W/m².K)

Condensation

The inverted roof construction can greatly reduce the risk of condensation in an existing building by keeping the roof structure and the waterproof layer above the dewpoint temperature.

Where the building is likely to have a high level of humidity, as in the case of swimming pools or commercial kitchens, condensation risk assessment should be undertaken by a suitably qualified professional. A method for calculating the risk of interstitial condensation is given in BS EN ISO 13788.

Roofs with high thermal capacity - such as concrete at least 50mm thick - do not undergo rapid cooling by rainwater run-off.

Fire

Inverted roofs ballasted with incombustible material, such as aggregate or paving slabs, readily achieve an external fire rating of FAA when tested to BS 476: Part 3: 1958. They offer adequate resistance to the external spread of fire as required by Building Regulation B4 (Regulation 19 in Scotland).

For further information on the fire performance of ROOFMATE boards the STYROFOAM Solution for roofs see BS 6203 and Agrément Certificate 97/3431.

Roof falls and drainage.

Good drainage is vital to the long-term performance of a flat roof. To ensure the minimum finished fall of 1:80 recommended in BS 6229, falls should be designed to 1:40. Inverted roof construction can be used on flat roofs designed with falls up to 1:11. Falls must be consistent, without deflections or depressions in which large quantities of water may pond. To perform effectively, ROOFMATE boards must not be totally submerged.

Guidance on the capacity and location of rainwater gutters and outlets is given in BS EN 12056: Part 3. Specify rainwater outlets which will accept run-off from both the top of the insulation and the surface of the waterproofing.

Roof waterproofing

The inverted roof concept can be used with a wide range of waterproofing materials, including mastic asphalt and high performance built-up bituminous felt (bituminous roofing felt with a core of organic fibre is not suitable).

Where roofs do not have a fall, the waterproofing should be to a tanking specification.

In renovation projects the inverted roof concept can be used to upgrade thermal performance of the roof: if the existing waterproof layer is in sound condition it may be retained but it may be desirable to overlay it with a new waterproof layer.

Separating layers

The recommendations for the use of separating layers in inverted roof construction are as follows:

- between waterproof layer and insulation:
  - mastic asphalt: BS 8218 requires a loose-laid non-woven polyester fleece 130 - 140g/m^2 lapped 200 - 300mm.
  - bituminous felts: separating layer not normally required.
  - single ply polymeric membranes: a loose-laid non-woven polyester fleece is normally recommended for pPVC membranes - consult the membrane supplier.
- between insulation and ballast:
  - to prevent fines from being washed under the insulation where they could damage the waterproof membrane use a loose-laid filter fabric, e.g. ROOFSTAT* N or ROOFSTAT R non-woven geotextiles.
  - to maintain the depth of ballast required to counter wind uplift at 50mm of washed 20 - 40mm nominal diameter aggregate irrespective of the insulation thickness, use a loose-laid non-woven geotextile with 140g/m^2 minimum density, e.g. ROOFSTAT R, lapped 300mm.

*Tradename of Terram Ltd.

Insulating ballasted inverted roofs: design considerations

General

The inverted roof system is ideally suited to the insulation of flat roofs of heavyweight construction, and offers a durable, attractive roof finish for roofs where maintenance traffic is expected (Figure 06).

STYROFOAM Solutions

The STYROFOAM Solution for insulating ballasted inverted roofs is ROOFMATE SL-X.

ROOFMATE SL-X is designed to give the maximum benefit in inverted roof construction:

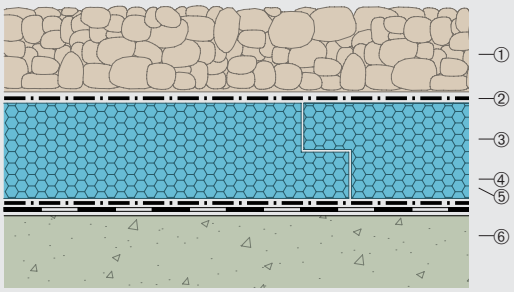
- a range of thicknesses from 50 to 200mm allows thermal performance to be matched to project requirements (see Table 06).
- shiplapped edges ensure a good interlock between boards, which helps prevent thermal bridging.
- rigid boards provide a firm base for the ballast layer.

For the full physical properties and performance characteristics of ROOFMATE SL-X see Product Data.

The ROOFMATE M^{in}K system

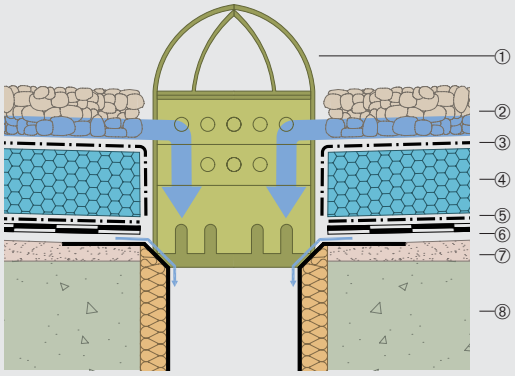
Allowing for rainwater cooling requires a 20% increase in insulation thickness. This can be reduced to 2% by use of the ROOFMATE MK separating layer together with ROOFMATE SL-X (see Agrément certificate 97/3431 - the ROOFMATE MinK system). ROOFMATE MK is waterproof, but at the same time water vapour permeable. It replaces the usual separating layer laid between the insulation and ballast (see Figure 07). Rainwater is prevented from reaching the waterproofing layer, thereby almost completely eliminating the rainwater cooling effect.

ROOFMATE MK should be loose-laid over the insulation, at right angles to the slope with 150mm laps running down the slope **(or if the depth of the aggregate ballast is to kept to a maximum of 50mm then 300mm laps will be required.)** At upstands and penetrations it should be turned up to finish above the surface of the ballast.



① ballast
② separating layer (if required)
③ ROOFMATE SL-X
④ separating layer (if required)
⑤ waterproof layer
⑥ concrete slab

Figure 06 >> Ballasted inverted roof



① outlet guard
② ballast
③ ROOFMATE MK separating layer
④ ROOFMATE SL-X
⑤ separating layer (if required)
⑥ waterproof layer
⑦ screed to falls
⑧ concrete slab

Figure 07 >> ROOFMATE M^{in}K system in the inverted roof

ROOFMATE MK is a spun bonded polyethylene geotextile with the following properties:

- water vapour permeable.
- water resistant.
- tear resistant.
- UV stable - can be left exposed outdoors for up to four months.
- fire - melts and shrinks away from a heat source (unclassifiable as regards Building Regulations).
- temperature - retains flexibility and toughness down to -73ºC, melting point is 135ºC.

Ballast

Both washed aggregate and dense concrete paving slabs are suitable as ballast for use with ROOFMATE SL-X insulation.

Aggregate

This gives a good appearance at an economical cost and should be 20 - 40mm nominal diameter, clean, washed and reasonably free from fines. The depth of aggregate required depends upon the thickness of the insulation and is shown in Table 07.

When boards are overlaid with a suitable separating layer (see Page 15) - such as ROOFSTAT R or ROOFMATE MK - lapped 300mm, then a 50mm depth of aggregate may be sufficient to counter wind uplift and flotation of the insulation. Additional ballast may, however, be needed in those areas subject to greater wind uplift, such as perimeters.

Aggregate should be replaced by paving slabs:-

- to form walkways where regular foot traffic is expected.
- where the kerb at the roof edge is too shallow to retain the aggregate.
- at perimeters, where calculations indicate aggregate will provide insufficient resistance to wind uplift or will be affected by wind scour.††

Paving slabs

Table 08 lists the recommended thicknesses for paving slabs used to ballast an inverted roof. The slabs should be raised off the insulation on spacers to allow drainage and to avoid rocking. Alternatively, slabs may be set on a 20mm bed of pea gravel or sand spread over a layer of ROOFSTAT R. The pea gravel bedding will assist drainage, support low strength slabs, accommodate changes of level and allow the use of thinner slabs: 40mm slabs with a 20mm depth of bedding will impose a total load of 140kg/m^2.

Thickness of ROOFMATE SL-X (mm)	Depth of aggregate (mm)	Approx weight of aggregate (kg/m^2)†
50	50	80
60	60	96
75	75	120
90	75	120
100	80	128
120	90	144
>120 <160	100	160
>161 <200	125	200

† assumes density of 16kg/m^2 per 10mm depth

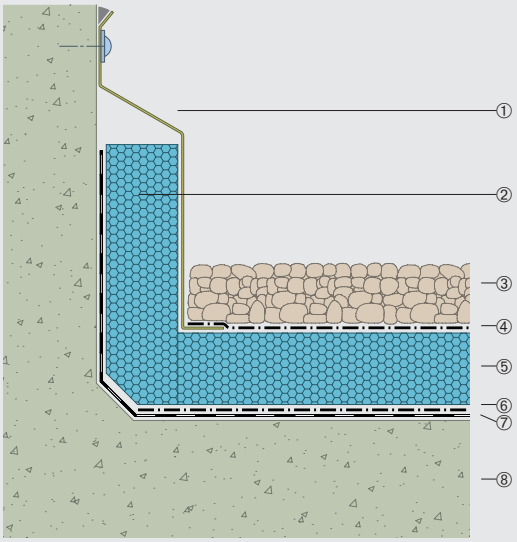
Table 12 Recommended depth of aggregate

Thickness of ROOFMATE SL-X (mm)	Thickness of paving slab† (mm)
50, 60	not less than 40
70, 90 100, 120	not less than 50
>120	not less than 60

† assumes dense concrete slabs to weigh approx. 25kg/m^2 per 10mm thickness

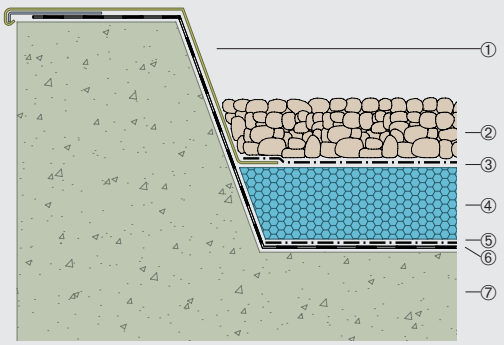
Table 13 Recommended slab thicknesses

†† see BRE Digest 311



① apron flashing
② ROOFMATE SL-X
③ ballast
④ separating layer (if required)
⑤ ROOFMATE SL-X
⑥ separating layer (if required)
⑦ waterproof layer
⑧ concrete slab

Figure 08 >> Ballasted inverted roof - detail at upstand



① cover flashing or capping
② ballast
③ separating layer (if required)
④ ROOFMATE SL-X
⑤ separating layer (if required)
⑥ waterproof layer
⑦ concrete slab

Figure 09 >> Ballasted inverted roof - detail at verge

Edge details

Upstands at parapets and abutments should be protected by ROOFMATE SL-X boards set vertically and covered with an apron flashing (Figure 08).

Extending the insulation in this way affords a consistent level of protection and helps to avoid thermal bridging. Apron flashings should be carried to at least 150mm above the surface of the ballast.

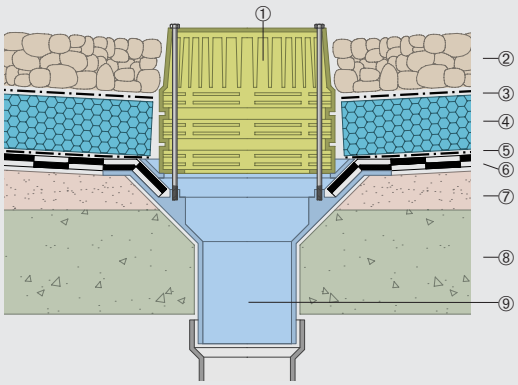
Kerbs, including those at verges and rooflights, should be high enough to contain the insulation and the ballast (Figure 09). ROOFMATE SL-X boards should be fitted tight against kerbs.

Drains and gutters

Outlet gratings may be raised on spacer rings to reduce the risk of blockage: cut a hole in the ROOFMATE SL-X boards to accommodate the outlets (Figure 10). A paving slab on spacer pads may be used above a flat grating (Figure 11).

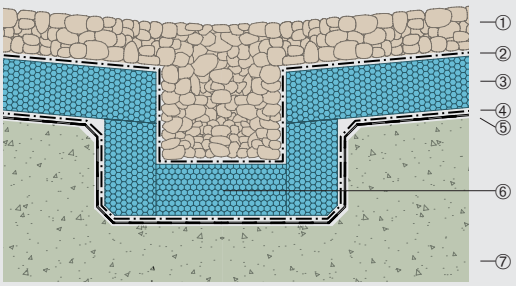
Where possible, line internal gutters with ROOFMATE SL-X to prevent thermal bridging, and maintain the ballast layer (Figure 12). Alternatively, the gutter may be spanned by ROOFMATE SL-X boards ballasted by paving slabs on spacer pads (Figure 13).

Where the roof drains to an edge gutter terminate aggregate ballast with a row of paving slabs on suitable supports (figure 14) and protect the edge of the ROOFMATE SL-X boards from UV light with a cover flashing.



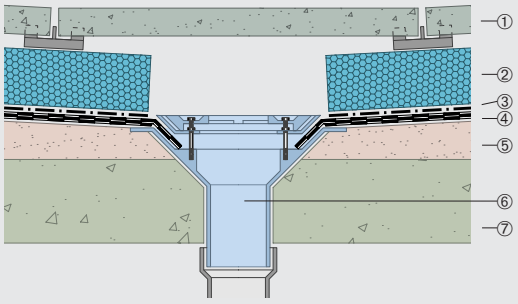
① outlet guard
② ballast
③ separating layer (if required)
④ ROOFMATE SL-X
⑤ separating layer (if required)
⑥ waterproof layer
⑦ screed to falls
⑧ concrete slab
⑨ roof outlet

Figure 10 >> Ballasted inverted roof - drain with outlet guard



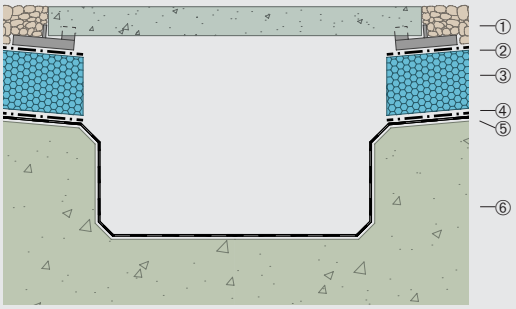
① ballast
② separating layer (if required)
③ ROOFMATE SL-X
④ separating layer (if required)
⑤ waterproof layer
⑥ ROOFMATE SL-X
⑦ concrete slab

Figure 12 >> Ballasted inverted roof - insulation within internal gutter



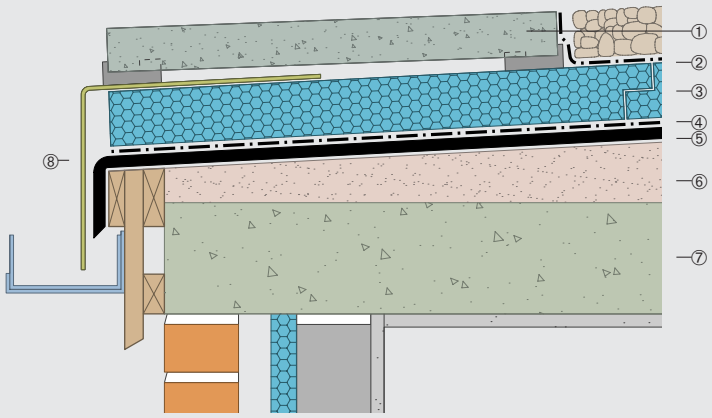
① paving slabs on spacer pads
② ROOFMATE SL-X
③ separating layer (if required)
④ waterproof layer
⑤ screed to falls
⑥ roof outlet
⑦ concrete slab

Figure 11 >> Ballasted inverted roof - outlet protected by paving slabs



① ballast
② separating layer (if required)
③ ROOFMATE SL-X
④ separating layer (if required)
⑤ waterproof layer
⑥ concrete slab

Figure 13 >> Ballasted inverted roof - insulation over internal gutter



① paving slab on spacer pads
② separating layer (if required)
③ ROOFMATE SL-X
④ separating layer (if required)
⑤ waterproof layer
⑥ screed
⑦ concrete slab
⑧ flashing

Figure 14 >> Ballasted inverted roof - detail at eaves

Specification

J21 Mastic asphalt roofing

710 Inverted roof insulation

J41 Built-up felt roof coverings

710 Inverted roof insulation

J42 Single layer polymeric roof coverings

810 Inverted roof insulation

››› Manufacturer and reference:

Dow Chemical Co. Ltd,

Building Solutions,

2 Heathrow Boulevard,

284 Bath Road, West Drayton, Middlesex, UB7 0DQ.

Tel: 020 8917 5050 - Fax: 020 8917 5413

ROOFMATE SL-X

Thickness†:

50/60/80/100/120/140/160/180/200mm

†delete as appropriate

Board size: 1250 x 600mm

Edge profile: shiplap

Design loading: 110kN/m²

Fire Classification: Reaction to fire:

BS EN 13164 Euroclass E

Working temperature range: -50°C to +75°C.

››› do not lay insulation until roof is clear of other subtrades.

››› clean off all dirt and debris from base.

››› lay separation layer as required.

››› set out to minimise cutting and avoid small cut pieces at perimeters and penetrations.

››› loose lay boards, tightly butted and to brick pattern, cut cleanly to fit closely around projections, upstands, rainwater outlets, etc.

››› on completion of laying ensure boards are in good condition, with no springing, flexing or rocking. Secure boards against wind uplift as soon as practicable.

Specify ballast layers with clauses 720, 730 or 731.

Insulating ballast inverted roofs: installation methods

Installation sequence

1. Inspect the roof to ensure it is clean.
   Plan the installation sequence and the layout of ROOFMATE SL-X boards.
2. Lay the separating layer (if required) over the waterproof layer; lap all edges by 200 - 300mm, at perimeters and penetrations turn up above the installed thickness of the insulation.
3. Lay ROOFMATE SL-X insulation boards in brick pattern with shiplap edges pushed together firmly (Figure 15).
4. Insulate upstands with ROOFMATE SL-X boards (Figure 08).
5. Fit ROOFMATE SL-X boards neatly around penetrations (Figure 16). Cut boards with a sharp knife or fine toothed saw.
6. Lay the filter layer (if required) with 150mm laps or if ROOFMATE MK 300mm laps at right angles to the slope. Arrange laps to run down the slope (Figure 17). At upstands and penetrations turn up the filter layer so it finishes above the surface of the ballast.
7. Lay paving slabs on supports around roof perimeters and penetrations as required.
8. Lay the ballast layer progressively. Work on an advancing front away from the point of access so all ballast material is carried across a protected waterproof layer (Figure 18).
9. Install cover flashings.

Key points

- careful setting out before installation begins will minimise cutting and wastage.
- take care not to over-stress any area of the roof while distributing the ballast.
- use scaffold boards when barrowing materials over ROOFMATE SL-X boards.

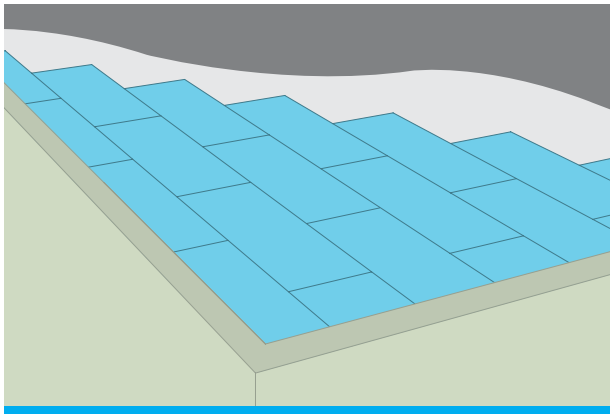


Figure 15

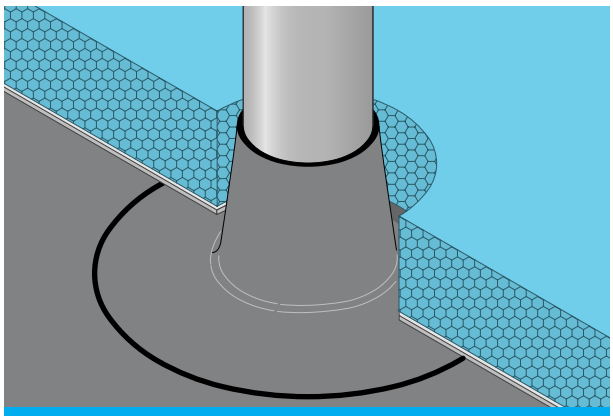


Figure 16

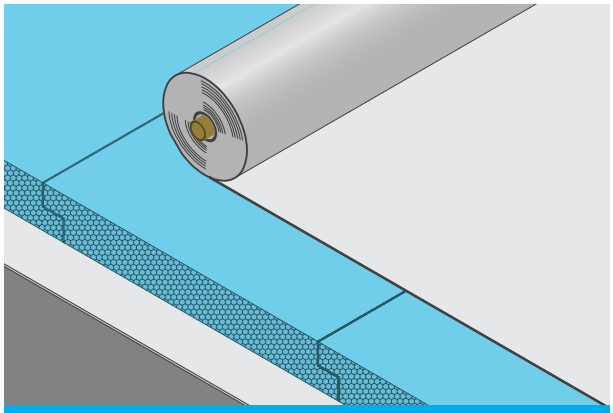


Figure 17

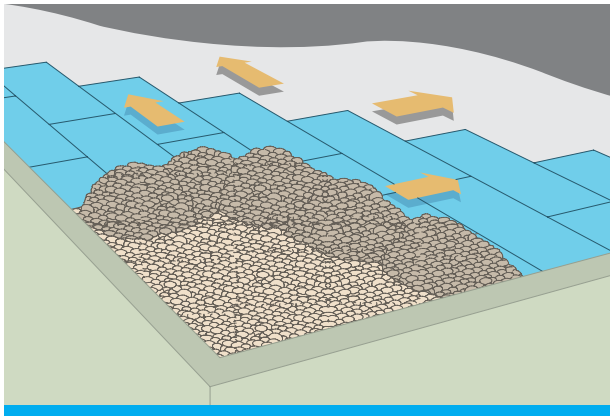


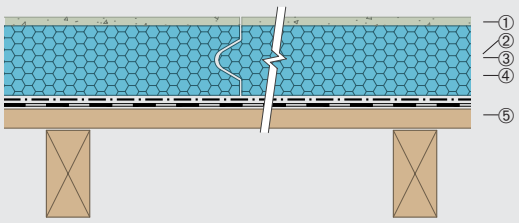
Figure 18

Insulating lightweight inverted roofs: design considerations

General

Lightweight inverted roofs are suitable for use with a wide range of waterproofing materials in both new and existing buildings where limited roof top access is expected (i.e. maintenance traffic only).

The system is not suitable for use on heavily trafficked areas, such as balconies and terraces, nor should it be used with loose-laid membranes.



① ROOFMATE LG-X
② separating layer (if required)
③ waterproof layer
④ timber deck
⑤ timber joist

Figure 19 >> Lightweight inverted roofs

STYROFOAM Solutions

The STYROFOAM Solution for insulating lightweight inverted roofs is ROOFMATE LG-X: it consists of STYROFOAM insulation boards with a factory applied top surface of modified mortar 10mm thick. The surface is mottled grey, resembling a cement:sand render with a wood float finish.

ROOFMATE LG-X is designed to give the maximum benefit in lightweight inverted roofs; the boards are:

- tongued and grooved on their long edges to ensure they lock together to give a continuous insulation layer, eliminating thermal bridging and reducing the effect of wind uplift.
- light enough for one man to handle.
- can be cut and shaped on site with a masonry saw.
- installed in one easy operation, avoiding the cost of a ballast layer.

Consult Page 08 for the full physical properties and performance characteristics of ROOFMATE LG-X boards.

U value	0.35	0.25	0.20	0.18	0.16
ROOFMATE LG-X (includes 10mm thick mortar topping)	100	160	220*	260*	320*

Roof build-up:
- ROOFMATE LG-X
- Separation layer
- Mastic asphalt 20mm
- Sand cement screed 50mm
- Concrete deck 200mm

Rainwater cooling penalty calculated to BS EN ISO 6946 Annex D4

* 2 layers required eg. 160mm ROOFMATE SL-X + 60mm ROOFMATE LG-X

Table 14 Required ROOFMATE LG-X thickness (mm) to meet U-values (W/m².K)

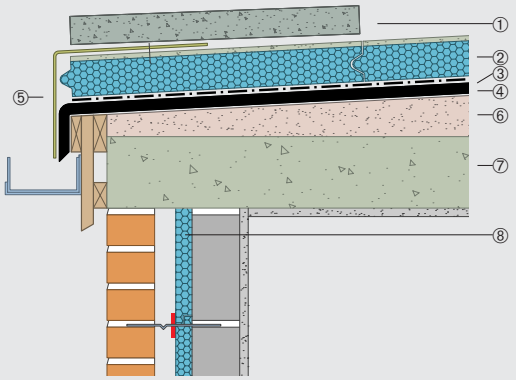
Wind uplift

ROOFMATE LG-X boards are designed to minimise the effect of wind uplift forces; the joints between boards are interlocking, but not airtight, so differences in pressure between the top and bottom surfaces of the boards - produced by wind blowing across the roof - rapidly equalise, reducing the uplift forces on the insulation.

When assessing the effect of wind uplift upon ROOFMATE LG-X boards on a lightweight inverted roof it is important to consider:

- **predicted uplift force:** predictions of wind uplift should be based upon the calculation methods given in BS 6339: Part 2.
- **means of attachment of the waterproof layer:** waterproof layers on lightweight inverted roofs may be partially or fully adhered or mechanically attached: the weight of ROOFMATE LG-X boards should be ignored when assessing the stability of the waterproof layer under windload.
- **laying pattern of boards:** ROOFMATE LG-X boards must be laid in brick pattern with their tongued and grooved edges fully interlocked.

- **parapets and roof kerbs:** at roof perimeters ROOFMATE LG-X boards must be protected from wind blowing directly underneath the boards: kerbs should extend at least 50mm above the top of the boards. On roofs with low wind exposure ROOFMATE LG-X boards may be laid to drain directly into an edge gutter. Protect the board edge with a cover flashing (Figure 20).
- **edge restraint:** the mortar topping to the ROOFMATE LG-X boards provides some resistance to uplift, but edge restraint is usually required at the roof perimeter and around large penetrations such as plant rooms. Edge restraint can be achieved by laying a single row of 50mm thick paving slabs or adhering the boards to the substrate with a suitable adhesive eg. Tixophalte*. If exceptionally high uplift forces are involved further rows of paving or possibly mechanical restraint will be required.



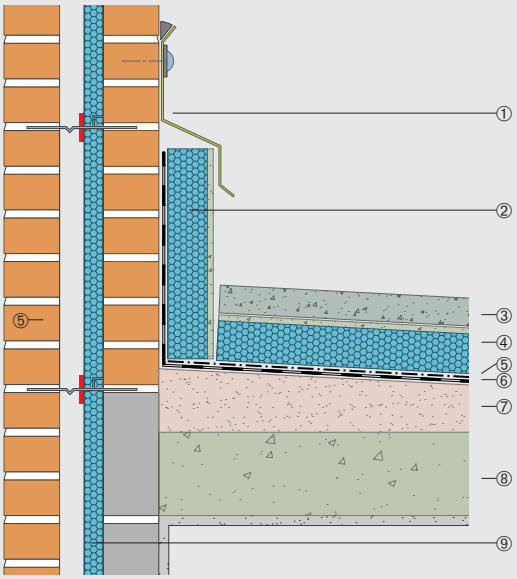
① paving slab
② ROOFMATE LG-X
③ separating layer (if required)
④ waterproof layer
⑤ flashing
⑥ screed to falls
⑦ concrete slab
⑧ WALLMATE CW-X

Figure 20 >> Lightweight inverted roof- detail at eaves

A ROOFMATE LG-X project assessment form is provided on page 34 of this brochure: the specifier should send a completed copy of the form to Dow for each project designed with ROOFMATE LG-X: on the basis of project information supplied Dow will calculate the amount and location of restraint required. For assistance in completing the form please contact Dow.

Edge details

Waterproof upstands should be protected by fitting ROOFMATE LG-X boards against the upstands and covering them with an apron flashing (Figure 21). Extending the insulation in this way also helps to avoid thermal bridging. Any apron flashing should terminate at least 150mm above the top of the boards.



① apron flashing
② ROOFMATE LG-X
③ paving slab
④ ROOFMATE LG-X
⑨ WALLMATE CW-X
⑤ separating layer (if required)
⑥ waterproof layer
⑦ screed to falls
⑧ concrete slab
⑨ WALLMATE CW-X

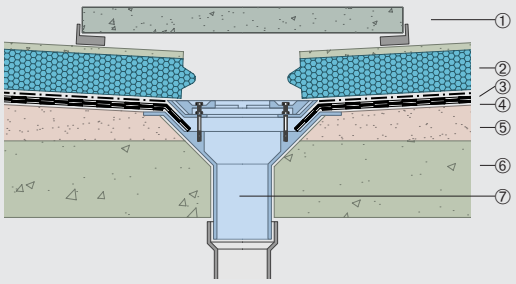
Figure 21 >> Lightweight inverted roof - detail at upstand

* available from Callenders Ltd. tel 01268 591155

Drains and gutters

Gratings for rainwater outlets may be raised on spacer rings to reduce the risk of blockage; cut a hole in the ROOFMATE LG-X board to accommodate the outlet.

Alternatively, a paving slab supported on spacer pads may be used above a flat grating (Figure 22).



① paving slab on spacer pads
② ROOFMATE LG-X
③ separating layer (if required)
④ waterproof layer
⑤ screed to falls
⑥ concrete slab
⑦ rainwater outlet

Figure 22 >> Lightweight inverted roof - detail at outlet

Specification

J41 Built-up felt roof coverings
710 Inverted roof insulation
J41 Built-up felt roof coverings
810 Inverted roof insulation
J42 Single layer polymeric roof coverings
810 Inverted roof insulation

››› **Manufacturer and reference:**

Dow Chemical Co. Ltd,
Building Solutions,
2 Heathrow Boulevard,
284 Bath Road, West Drayton, Middlesex, UB7 0DQ.
Tel: 020 8917 5050 - Fax: 020 8917 5413

ROOFMATE LG-X
Roofs for maintenance traffic
Thickness†: 60/70/90/110/130†† mm
(including 10mm mortar topping)
†delete as appropriate
††thicker products available on request up to 190 mm
Board size: 1200 x 600mm
Edge profile: tongued and grooved on long sides, butt edged on short sides.
Design loading: 110kN/m^2
Fire Classification: Reaction to fire:
BS EN 13164 Euroclass E (insulation only)
Working temperature range: -50°C to +75°C.

››› do not lay insulation until roof is clear of other subtrades.
››› clean off all dirt and debris from base.
››› set out to minimise cutting and avoid small cut pieces at perimeters and penetrations.
››› loose lay boards, tightly butted and to brick pattern, cut cleanly to fit closely around projections, upstands, rainwater outlets, etc.
››› on completion of laying ensure boards are in good condition, with no springing, flexing or rocking. Secure boards against wind uplift as soon as practicable.

Insulating lightweight inverted roofs: installation methods

Installation sequence

1. Inspect the roof to ensure it is clean. Plan the installation sequence and the layout of ROOFMATE LG-X boards.
2. Lay the separating layer (if required) over the waterproof layer; lap all edges by 200 - 300mm, at the perimeters and penetrations turn up above the installed thickness of the insulation.
3. Plan and set out ROOFMATE LG-X boards with 3 - 5mm between adjacent boards and between boards and upstands, kerbs and penetrations.
4. Start laying the first row of boards with their long edge against the longest side of the roof. If there is an angle fillet chamfer the board edges to get a good fit.
5. Do not use cut pieces of less than half board length at the perimeter: they may be used towards the roof centre.
6. Lay the second row of boards, staggered by half a board length, ensure the tongued and grooved edges interlock.
7. Stagger subsequent rows by half board lengths (Figure 23).
8. At penetrations cut the board across its width at the line of the penetration and neatly cut a shaped recess in each part so the edges of the ROOFMATE LG-X boards still interlock.
9. At changes in roof slope use a masonry saw to cut the mortar topping of the ROOFMATE LG-X boards along the line of change of plane. This will reduce cracking as the STYROFOAM insulation flexes under load. Leave the saw cut open.
10. Place the specified edge restraint along the roof perimeter and around large penetrations.
11. Install cover flashings.

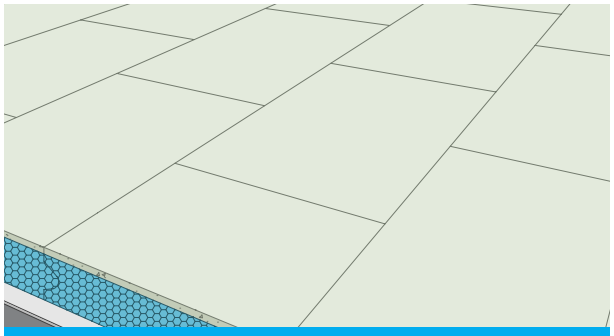


Figure 23

Key points

- careful setting out before installation begins will minimise cutting and wastage.
- when placing pallet loads of ROOFMATE LG-X onto the roof, distribute them to prevent overloading.
- keep the waterproof layer clear of debris throughout installation.
- protect ROOFMATE LG-X boards from damage by subsequent construction activity: replace any damaged boards.
- do not store unrestrained ROOFMATE LG-X boards on the roof.

Mortar topping

As with most mortar coatings, hairline cracks may develop in the mortar topping of ROOFMATE LG-X boards; such cracks will have no effect upon the performance of the product. They will not propagate, but will tend to heal as hydration of the cement continues.

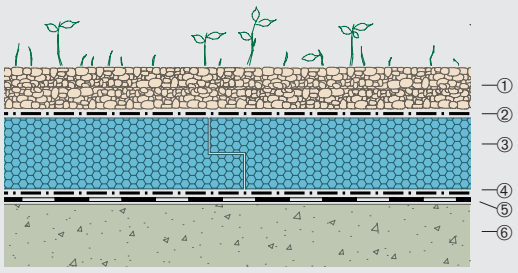
Accidental damage to the topping of ROOFMATE LG-X boards can be repaired in-situ using a suitable latex-modified cement.

Insulating green roofs: design considerations

General

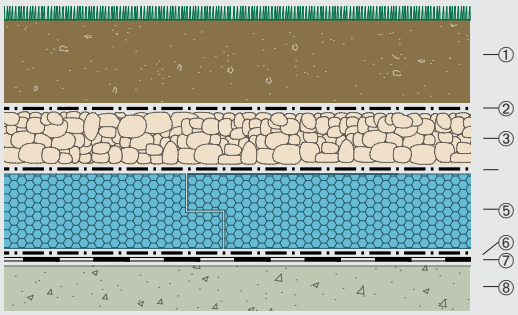
Flat roofs of suitable construction may be used to provide planted or landscaped areas which can offer a valuable amenity within the built environment. Such 'green' roofs can enhance the appearance of the building and provide additional outdoor facilities for building users.

An inverted roof with ROOFMATE insulation is the ideal solution for 'green' roofs where landscaping or planting is provided. The insulation boards protect the waterproof layer and the planting provides necessary ballast (Figures 24 and 25).



① planting / drainage layer (50-150mm)
② filter layer
③ ROOFMATE SL-X
④ separating layer (if required)
⑤ waterproof layer
⑥ concrete slab

Figure 24 >> Extensive green roof



① planting layer (150-500mm)
② filter layer
③ drainage layer
④ filter layer
⑤ ROOFMATE SL-X
⑥ separating layer (if required)
⑦ waterproof layer
⑧ concrete slab

Figure 25 >> Intensive green roof

STYROFOAM Solutions

The STYROFOAM Solution for insulating green roofs is ROOFMATE SL-X.

ROOFMATE SL-X is designed to give the maximum benefit in inverted roof construction; it is:

- rot proof - performance unaffected by conditions below the plant-bearing layer.
- available in a range of thicknesses from 50mm to 200mm allow thermal performance to be matched to project requirements.
- made with shiplapped edges to ensure a good interlock between boards, preventing thermal bridging.

Consult Page 08 for the full physical properties and performance characteristics of ROOFMATE SL-X.

Waterproof layers

Suitable waterproof layers for green roof constructions include:

- mastic asphalt.
- modified bitumen membranes.

The ROOFMATE SL-X boards will help protect the waterproof layer from root penetration: consult the membrane manufacturer for information on suitability and protection.

Filter layers

Filter layers will be required above the drainage layer and the insulation to prevent fines being washed down to the drainage and waterproof layers. Suitable materials include geotextiles with minimum weight of 140g/m^2, such as ROOFSTAT R.

Planting

The planting on a green roof may be:

- **extensive:** using a thin plant-bearing layer (50-150mm) and hardy plants such as sedums and grasses. Extensive green roofs are not usually intended for access. Once the planting is established - which may take only a few months - it requires very little maintenance (Figure 24).
- **intensive:** using a thick plant-bearing layer (150-500mm) and traditional garden plants including lawn-grass, shrubs and even small trees. Intensive green roofs require full access for maintenance, are suitable for roof gardens and are often combined with paved areas and terraces to provide amenity areas. The type of planting chosen will determine the roof construction above the filter layer: extensive planting requires a planting layer which will retain some water whilst intensive planting requires a thicker, soil-based plant-bearing layer and a drainage layer (Figure 25).

Loading

The load imposed by saturated soil can be as high as 25kg/m^2 per 10mm depth, and that of the gravel drainage layer 16kg/m^2 per 10mm depth. A further load of 20kg/m^2 should be allowed for water logging of the gravel drainage layer (minimum 50mm depth).

Specification

J21 Mastic asphalt roofing
710 Inverted roof insulation
J41 Built-up felt roof coverings
710 Inverted roof insulation
J42 Single layer polymeric roof coverings
810 Inverted roof insulation

- **Manufacturer and reference:**

  Dow Chemical Co. Ltd,
  Building Solutions,
  2 Heathrow Boulevard,
  284 Bath Road, West Drayton, Middlesex, UB7 0DQ.
  Tel: 020 8917 5050 - Fax: 020 8917 5413

  ROOFMATE SL-X
  Thickness†:
  50/60/75/80/90/100/120/140/160/180/200mm
  †delete as appropriate
  Board size: 1250 x 600mm
  Edge profile: shiplap
  Design loading: 110kN/m^2
  Fire Classification: Reaction to fire:
  BS EN 13164 Euroclass E
  Working temperature range: -50°C to +75°C.

- do not lay insulation until roof is clear of other subtrades.
- clean off all dirt and debris from base.
- set out to minimise cutting and avoid small cut pieces at perimeters and penetrations.
- loose lay boards, tightly butted and to brick pattern, cut cleanly to fit closely around projections, upstands, rainwater outlets, etc.
- on completion of laying ensure boards are in good condition, with no springing, flexing or rocking. Secure boards against wind uplift as soon as practicable.

Specify the green roof covering with clause 770.

Insulating green roofs: installation methods

Installation sequence

1. Inspect the roof to ensure it is clean. Plan the installation sequence and the layout of ROOFMATE SL-X boards.
2. Lay the separating layer (if required) over the waterproof layer; lap all edges by 200 - 300mm, at perimeters and penetrations turn up above the installed thickness of the insulation.
3. Lay ROOFMATE SL-X insulation boards in brick pattern with shiplap edges pushed together firmly.
4. Insulate upstands with ROOFMATE SL-X boards.
5. Fit ROOFMATE SL-X boards neatly around penetrations. Cut boards with a sharp knife or fine toothed saw.
6. Lay the filter layer with 150mm laps at right angles to the slope. Arrange laps to run down the slope. Turn up the filter layer at upstands and penetrations.
7. Proceed with drainage layer, (50mm deep gravel graded 20 - 30mm) soil and planting, taking care not to disturb the ROOFMATE SL-X boards and filter layer.

Key points

- careful setting out before installation begins will minimise cutting and wastage.
- work on an advancing front away from the point of access so all loading material is carried across a protected waterproof layer.
- take care not to over-stress any area of the roof while distributing the soil layer.
- use scaffold boards when wheel barrowing materials over ROOFMATE SL-X boards.

Inverted roofs for renovation projects: design considerations

General

The inverted roof concept can be used to upgrade the insulation level of an existing roof without the need to remove and renew the existing waterproof layer, subject to certain conditions:

- the structure must be capable of carrying the additional load.
- the existing waterproof layer must be sound.
- adequate falls and drainage outlets must be in place.

Adopting the inverted roof systems allows work to continue without interruption and with no need to disturb the building interior.

Both the ballasted inverted roof and the lightweight solutions are suitable for renovation projects: the choice of solution will depend upon the loadbearing capacity of the roof structure and other project requirements.

Always obtain the advice of a roofing specialist, who should inspect the existing roof to confirm:

- drainage.
- falls.
- outlets.
- waterproof layer.
- details.
- penetrations.

The STYROFOAM Solutions for the renovation of flat roofs are ROOFMATE SL-X and ROOFMATE LG-X.

ROOFMATE SL-X is designed to give the maximum benefit in ballasted inverted roof construction:-

- a range of thicknesses from 50-200mm allows thermal performance to be matched to project requirements (see Table 06 on Page 14).
- shiplapped edges ensure a good interlock between boards, which helps prevent thermal bridging.
- rigid boards provide a firm base for the ballast layer.

ROOFMATE LG-X consists of STYROFOAM insulation boards with a factory applied top surface of modified mortar 10mm thick. The surface is mottled grey, resembling a cement:sand render with a wood float finish.

ROOFMATE LG-X is designed to give the maximum benefit in lightweight inverted roofs; the boards are:

- tongued and grooved on their long edges to ensure they lock together to give a continuous insulation layer, reducing the effect of wind uplift and eliminating thermal bridging.
- light enough for one man to handle and can be cut and shaped on site with a masonry saw.
- installed in one easy operation, avoiding the cost of a ballast layer.

Consult Page 08 for the full physical and performance properties of ROOFMATE SL-X and ROOFMATE LG-X.

Loading

Ensure the existing structure is able to support the additional load imposed by the insulation and/or loading layer; those additional loads are:

- **minimum 100kg/m² for a ballasted solution.**
- **minimum 30kg/m² for a lightweight solution.**

Waterproof layer

The condition of the waterproof layer must be checked. Whilst ROOFMATE boards will protect an existing layer, and thus increase its life expectancy, they are not a cure for failure of the waterproof layer.

Localised defects in a waterproof layer, which otherwise is in good condition, must be repaired.

A waterproof layer which is near the end of its useful life may be overlaid with a new waterproof layer. Where a roof has no drainage falls the waterproof layer should be to a tanking specification.

Small penetrations such as screed vents and cable ducts require careful detailing: it may be preferable to eliminate many existing features and make good the waterproofing locally.

Existing bitumen felt may have a bonded covering of stone chippings. Before overlaying with ROOFMATE boards sweep off all loose chippings and lay a cushioning layer, such as ETHAFOAM* 222E.

Interstitial moisture

Typically a heavyweight roof being considered for renovation will have little or no insulation above the concrete slab, and no VCL below the slab. Consequently, there is a high probability of condensation occurring at the interface of the concrete and the waterproof layer during the winter. The build up of water in the top of the concrete may be increased by any leakage through defects in the waterproof layer, in which case the summer 'dry-out' of condensation will be insufficient to remove moisture from the concrete, resulting in a permanently waterlogged slab.

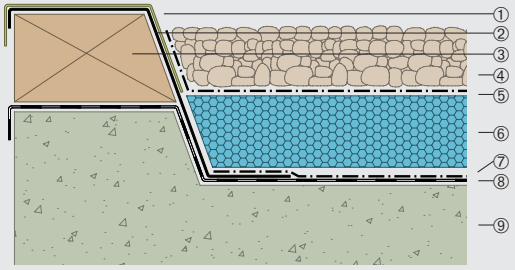
The installation of an inverted roof system, in conjunction with any remedial treatment necessary for the waterproof layer, will substantially reduce the risk of condensation and allow the slab to dry out.

Using an inverted roof, any insulation already in the roof construction beneath the waterproofing layer should be removed to avoid the risk of internal condensation. If in doubt carry out a Condensation Risk Analysis.

Edge details

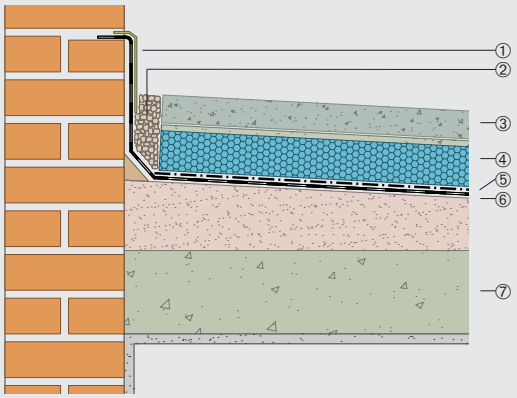
Upgrading an existing roof by the addition of ROOFMATE insulation will raise the finished surface level by the combined thickness of the insulation and any ballast layer. Parapets, abutments, penetrations and flashings should be modified to ensure the roof is adequately contained and weatherproof. The edges of ROOFMATE LG-X boards must be protected from sunlight and detailing must prevent wind blowing directly under the boards (Figure 26).

For renovation projects using ROOFMATE LG insulation, the flashing need only extend 50mm above the top surface of the boards, so long as a 50mm, aggregate filled, gap is left between the boards and the perimeter (Figure 27).



① flashing
② waterproof layer
③ timber kerb
④ ballast
⑤ separating layer (if required)
⑥ ROOFMATE SL-X
⑦ separating layer (if required)
⑧ waterproof layer
⑨ existing slab

Figure 26 >> Renovated inverted roof - detail at kerb



① flashing
② ballast
③ paving slab
④ ROOFMATE LG-X
⑤ separating layer (if required)
⑥ waterproof layer
⑦ existing slab

Figure 27 >> Renovated inverted roof - detail at upstand

* Trademark of The Dow Chemical Company

Drainage

Rainwater outlets must be capable of receiving run-off from the top of the insulation and from the waterproof layer.

If existing falls are inadequate:

- remove waterproof layer, lay screed to falls, provide new waterproof layer.
- remove waterproof layer and replace with new to a tanking specification.
- install additional rainwater outlets at the low points.

ROOFMATE boards should not be installed where they will be submerged in ponded water.

Specification

Specifications for renovation projects will be similar to those for new build projects, but may need to include clauses to:

- provide a drainage fall to the roof.
- repair or replace waterproof layer.
- extend shallow roof kerbs.
- install additional rainwater outlets in areas where water ponds.
- modify gratings or rainwater outlets.
- level out large depressions in the substrate and repair the waterproof layer.

Maintenance

All roofs should be inspected as part of normal maintenance procedures. Inspections should cover the waterproof layer, outlets, gutters, flashings and detail work. The inspection should confirm that neither the insulation nor ballast has been displaced, particular care should be taken with ROOFMATE LG-X.

In some environments there may be weed growth on the roof. Whilst this is unlikely to damage an inverted roof it is advisable to eradicate weed growth by removing it or by using a suitable water-based weed killer. Check its compatibility with STYROFOAM before use.

ROOFMATE LG-X Project assessment sheet

Fax Number: 020 8917 5413

Information supplied by: _____ Date: _____

Project data

- Project name: _____
- Site address: (including Post Code) _____
- Specifiers name: _____

Address: _____

Contact name: _____

Telephone number: _____ Fax number: _____

- Area of ROOFMATE LG-X: _____
- Thickness of ROOFMATE LG-X: _____
- Type of waterproofing: _____
- Roofer's name: _____

Address: _____

Contact name: _____

Telephone number: _____ Fax number: _____

- Date to be roofed: _____

Roof details

- Please provide a complete roof plan: _____
- Roof height: _____ Roof width: _____ Roof length: _____
- Parapet height: _____ Parapet width: _____
- Is the roof slope less than 5 degrees? _____
- Are there any steps or changes in the roof surface? _____
- Is there a plant room or any other structure on the roof - if so provide details? _____

_____

- Will ROOFMATE LG-X boards (and paving slabs if required) be concealed by a parapet/kerb along all edges?

Give details: _____

_____

_____

References

Agrément certificates

- 87/1836 Pitched roofs - warm roof concept
- 88/2105 Cavity walls
- 92/2782 Floors
- 97/3431 Inverted roofs

Building Regulations

- Approved Documents to the Building Regulations
  - A Structure
  - B Fire safety
  - C Site preparation and resistance to moisture
  - E Resistance to the passage of sound
  - L1A Conservation of fuel and power in new dwellings
  - L1B Conservation of fuel and power in existing dwellings
  - L2A Conservation of fuel and power in new buildings other than dwellings
  - L2B Conservation of fuel and power in existing buildings other than dwellings
- Technical Handbooks to Building Standards Scotland Regulations

BRE publications

- Thermal insulation: avoiding risks BR 262:2002.
- Conventions for U-value calculations
  - B. Anderson BR443: 2006
- Building Elements: 'Floors and Flooring' – PW Pye and HW Harris BR 332: 1997
- Foundations, basements and external walls BR 440: 2002.
- BRE Digest 311. Wind scour of gravel ballast on roofs.
- BRE IP 17/01. Assessing the effects of thermal bridging at junctions and around openings in the external elements of buildings.

British Standards

- BS 743: 1970: Specification for materials for damp proof courses.
- BS 476: Fire tests on building materials and structures.
  Part 2: 1987. Methods for determination of the fire resistance of loadbearing elements of construction.
  Part 3: 1958: External fire exposure roof test
- BS 743:1970: Specification for Materials for Damp proof courses.
- BS 1202: Specification for nails.
  Part 1: 2002: Steel nails.
- BS 5250: 2002: Code of practice for control of condensation in buildings.
- BS 5427: Code of practice for the use of profiled sheet for roof and wall cladding on buildings.
  Part 1: 1996: Design.
- BS 5950: Structural use of steelwork in building.
  Part 4: 1994 Code of practice for design of composite slabs with profiled steel sheeting.
- BS 5268: Structural use of timber.
  Part 4: Fire resistance of timber structures.
  – Section 4.2: 1990: Recommendations for calculating fire resistance of timber stud walls and joisted floor constructions.
  Part 7: Recommendations for the calculation basis for span tables.
  – Section 7.1: 1989: Domestic floor joists.
- BS 5502: Buildings and structures for agriculture.
  Part 23: 1990: Code of practice for fire precautions.
  Part 42: 1990: Code of practice for design and construction of pig buildings.
  Part 71: 1992: Code of practice for design and construction of ventilated stores for potatoes and onions.
- BS 5534: 2003: Code of practice for slating and tiling.
- BS 5628: Code of practice for use of masonry.
  Part 3: 1985: Materials and components, design and workmanship.
- BS 6203: 1991 (1996) Guide to fire characteristics and fire performance of expanded polystyrene materials used in building applications.
- BS 6229: 2003: Code of practice for flat roofs with continuously supported coverings.
- BS 6398: 1983: Specification for bitumen damp proof courses for masonry.
- BS 6399: Loading for Buildings
  Part 1: 1996: Code of practice for dead and imposed loads.
  Part 2: 1997: Code of practice for wind loads.
  Part 3: 1988: Code of practice for imposed roof loads.

References

- BS 6515: 1984 (1996) Specification for polyethylene damp-proof courses for masonry.
- BS 8000: Workmanship on building sites.
  Part 4: 1989: Code of practice for waterproofing.
- BS 8102: 1990: Code of practice for protection of structures against water from the ground.
- BS 8103 Structural Design of low-rise buildings.
  Part 1: 1995: Code of practice for stability, site investigation, foundations and ground floor slabs for housing.
- BS 8110: Structural use of concrete.
  Part 1: 1997: Code of practice for design and construction.
- BS 8203: 2001 Code of practice for resilient floor coverings.
- BS 8204: Screeds, bases and in-situ floorings.
  Part 1: 1999 Code of practice for concrete bases and cement sand levelling screeds to receive floorings.
  Part 2: 1999: Code of practice for concrete wearing surfaces.
- BS 8215: 1991: Code of practice for design and installation of damp proof courses in masonry construction.
- BS 8218: 1998: Code of practice for mastic asphalt roofing.
- CP 1018: 1971 (1993) Electric floorwarming systems for use with off-peak and similar supplies of electricity.

European standards

- BS EN 1264: Floor heating. Systems and components.
  Part 4: 2001 Installation
- BS EN 12056: Gravity drainage systems inside buildings.
  Part 3: 2000: Roof drainage, layout and calculation.
- BS EN 13164: 2001 Thermal insulation products for buildings - Factory made products of extruded polystyrene (XPS) specification.
- BS EN 13501: Fire classification of construction products and building elements.
  Part 1: Classification using test data from reaction to fire tests
- BS EN 13370: 1998 Thermal performance of buildings – Heat transfer via the ground – Calculation methods
- BS EN 13789: 1999: Thermal performance of buildings - Transmission heat loss coefficient - Calculation method.

International standards

- BS EN ISO 6946: 1997 Building components and building elements – Thermal resistance and thermal transmittance – Caculation method.

Other publications

- CIBSE Guide A (1999)
- DEFRA/DTLR Robust Details – Limiting thermal bridging and air leakage: Robust Construction details for dwellings and similar buildings. 2002
- NBS Domestic Heating Compliance Guide: 2006

List of stockists: Uk and Ireland

Scotland

01 Aberdeen
Sheffield Insulations Limited,
Broadfold Road, Bridge of Don,
Aberdeen AB23 8EE

Tel: (01224) 825 825
Fax: (01224) 822 892

02 Blairgowrie
Sheffield Insulations Limited,
The Granary Office, Lower Mill Street,
Blairgowrie, Perthshire PH10 6AQ

Tel: (01250) 873 611
Fax: (01250) 875 252

03 Bellshill
Sheffield Insulations Limited,
Righead Industrial Estate,
Bellshill, Lanarkshire ML4 3NA

Tel: (01698) 575 700
Fax: (01698) 575 701

North East

04 Leeds
Sheffield Insulations Limited,
Sussex Avenue, Leeds LS10 2LF

Tel: (0113) 385 7700
Fax: (0113) 385 7701

05 Newcastle
Sheffield Insulations Limited,
Sanderson Street,
off Scotswood Road,
Newcastle Upon Tyne NE4 7LW

Tel: (0191) 226 3110
Fax: (0191) 226 3111

06 Sheffield
Sheffield Insulations Limited,
Nunnery Drive, Sheffield S2 1TA

Tel: (0114) 241 3000
Fax: (0114) 241 3001

North West

07 Burscough
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Recommendations

The STYROFOAM range of blue extruded foamed polystyrene insulation products includes FLOORMATE, ROOFMATE, WALLMATE and PERIMATE.

STYROFOAM products contain a flame retardant additive to inhibit accidental ignition from a small fire source. STYROFOAM is, however, combustible and if exposed to an intensive fire may burn rapidly.

During shipment, storage, installation and use STYROFOAM products should not be exposed to flames or other ignition sources.

Fire classification is based on small-scale tests, which may not reflect the reaction of the products in its end use state under actual fire conditions.

STYROFOAM products should, when installed, be adequately protected from direct exposure to fire.

Recommendations about the methods, use of materials and construction details are given as a service to designers and contractors. These are based on the experience of Dow with the use of STYROFOAM products. Any drawings are meant only to illustrate various possible applications and should not be taken as a basis for design. Since Dow is a materials supplier and exercises no control over the installation of STYROFOAM products, no responsibility is accepted for such drawings and recommendations.

In particular, no responsibility is accepted by Dow for the systems in which STYROFOAM is used or the method of application by which it is installed. The legal obligations of Dow in respect of any sale of STYROFOAM products shall be determined solely by the terms of the respective sales contract.

Notes

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