



# Styrozone® Inverted Roofs

INSULATION FOR PROTECTED MEMBRANE FLAT ROOFS AND GREEN ROOFS



- High performance rigid extruded polystyrene insulation – thermal conductivities as low as 0.029 W/m·K
- Protects waterproofing membrane
- Minimal water absorption
- High compressive strength
- Withstands freeze / thaw cycling
- Compatible with green roof systems
- Resistant to the passage of water vapour
- Easy to handle and install
- Ideal for new build and refurbishment
- Non-deleterious material
- Manufactured with a blowing agent that has zero ODP



*Low Energy –  
Low Carbon Buildings*

# Typical Constructions and U-values

## Assumptions

The U-values in the tables that follow have been calculated, under a management system certified to the BBA Scheme for Assessing the Competency of Persons to Undertake U-value and Condensation Risk Calculations, using the method detailed in BS / I.S. EN ISO 6946: 2007 (Building components and building elements. Thermal resistance and thermal transmittance. Calculation method) and using the conventions set out in BR443 (Conventions for U-value calculations). The method detailed in part D4.2 of BS / I.S. EN ISO 6946: 2007 has been used to take account of the effect of the high performance, non-woven polyethylene membrane over the insulation, and an (fx) factor  $\leq 0.002$  has been assumed. They are valid for the constructions shown in the details immediately above each table.



They assume a nominal selection of post-codes, selected to represent the influence of geographical variations in rainfall on thermal performance.

The ceiling, where applicable, is taken to be a 3 mm skim coated 12.5 mm plasterboard with a cavity between it and the underside of the deck.

*NB For the purposes of these calculations the standard of workmanship has been assumed good and therefore the correction factor for air gaps has been ignored.*

*NB The figures quoted are for guidance only. A detailed U-value calculation together with condensation risk analysis should be completed for each individual project.*

*NB If your construction is different from those specified and / or to gain a comprehensive U-value calculation along with a condensation risk analysis for your project please consult the Kingspan Insulation Technical Service Department for assistance (see rear cover).*

## U-value Table Key

Where an **X** is shown, the U-value is higher than the worst of the maximum new build area weighted average U-values allowed by the 2010 Editions of Approved Documents L to the Building Regulations (England & Wales), the 2010 Editions of Technical Handbooks Section 6 (Scotland), the 2006 Editions of Technical Booklets F (Northern Ireland), or the 2008 Editions of Technical Guidance Documents L\* (Republic of Ireland).

\* Excluding Change of Use and Material Alterations.

## Concrete Deck with Paving Slab Ballast

### Dense Concrete Deck with Suspended Ceiling

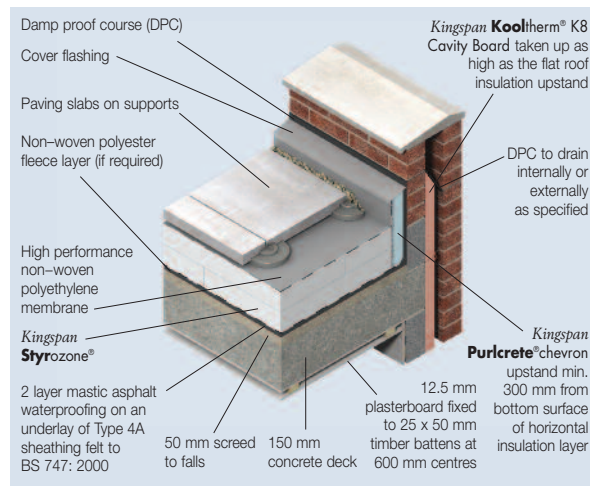


Figure 1

### U-values (W/m<sup>2</sup>-K) with Different Grades of Kingspan Styrozone® for a Nominal Selection of Post-Codes

Insulant Thickness (mm)	Post-Code				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
<b>Kingspan Styrozone® N 300 R</b>					
120	X	X	X	X	X
140	0.24	0.24	0.24	0.25	0.24
160	0.21	0.21	0.21	0.22	0.21
180	0.20	0.20	0.20	0.21	0.20
100 + 100	0.17	0.17	0.17	0.19	0.17
120 + 100*	0.16	0.16	0.16	0.17	0.16
120 + 120	0.15	0.15	0.15	0.16	0.15
140 + 120*	0.14	0.14	0.14	0.15	0.14
140 + 140	0.13	0.13	0.13	0.14	0.13
160 + 140*	0.12	0.12	0.12	0.13	0.12
160 + 160	0.11	0.11	0.11	0.13	0.11
180 + 160*	0.11	0.11	0.11	0.12	0.11
180 + 180	0.10	0.10	0.10	0.12	0.10
140 + 120 + 120*	0.09	0.09	0.09	0.11	0.09
140 + 140 + 140	0.09	0.09	0.09	0.10	0.09
<b>Kingspan Styrozone® H 350 R</b>					
80	X	X	X	X	X
100	0.25	0.25	0.25	X	0.25
120	0.21	0.21	0.21	0.23	0.21
140	0.20	0.20	0.20	0.21	0.20
160	0.17	0.17	0.17	0.19	0.17
100 + 80*	0.15	0.15	0.15	0.16	0.15
100 + 100	0.13	0.13	0.13	0.15	0.13
120 + 100*	0.12	0.12	0.12	0.14	0.12
120 + 120	0.11	0.11	0.11	0.13	0.11
140 + 120*	0.11	0.11	0.11	0.12	0.11
140 + 140	0.10	0.10	0.10	0.12	0.10
160 + 140*	0.10	0.10	0.10	0.11	0.10
160 + 160	0.09	0.09	0.09	0.11	0.09
120 + 120 + 100*	0.08	0.08	0.08	0.10	0.08

\* Where there are multiple layers of insulation of different thicknesses the thickest insulation board is installed first.

# Concrete Deck with Gravel Blast

## Dense Concrete Deck with Suspended Ceiling

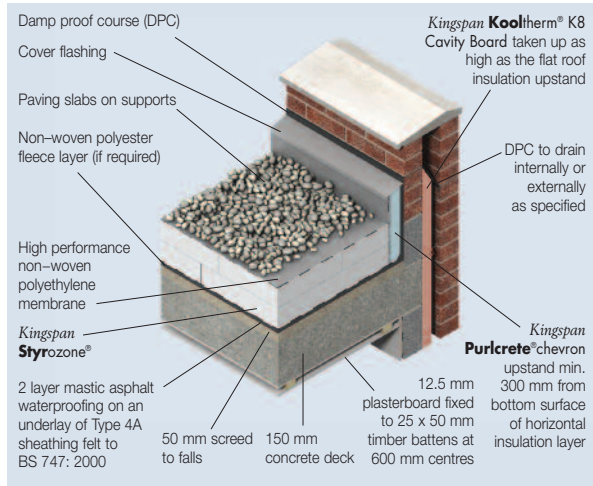


Figure 2

## Dense Concrete Deck with no Ceiling

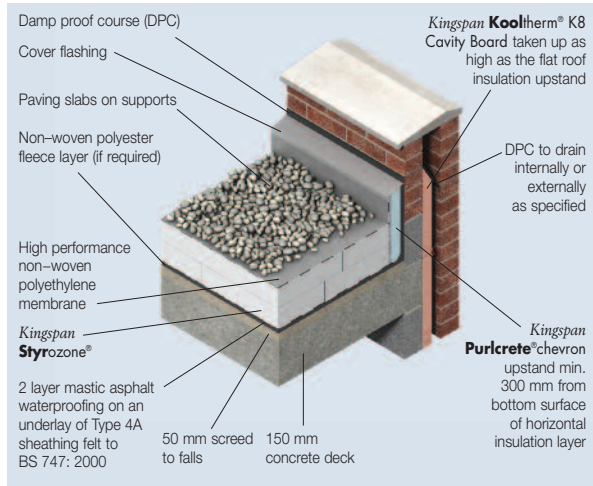


Figure 3

U-values (W/m <sup>2</sup> ·K) with Different Grades of Kingspan Styrozone <sup>®</sup> for a Nominal Selection of Post-Codes					
Insulant Thickness (mm)	Post-Code				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
<b>Kingspan Styrozone<sup>®</sup> N 300 R</b>					
120	X	X	X	X	X
140	0.24	0.24	0.24	0.25	0.24
160	0.21	0.21	0.21	0.22	0.21
180	0.20	0.20	0.20	0.21	0.20
100 + 100	0.17	0.17	0.17	0.19	0.17
120 + 100*	0.16	0.16	0.16	0.17	0.16
120 + 120	0.15	0.15	0.15	0.16	0.15
140 + 120*	0.14	0.14	0.14	0.15	0.14
140 + 140	0.13	0.13	0.13	0.14	0.13
160 + 140*	0.12	0.12	0.12	0.13	0.12
160 + 160	0.11	0.11	0.11	0.13	0.11
180 + 160*	0.11	0.11	0.11	0.12	0.11
180 + 180	0.10	0.10	0.10	0.12	0.10
140 + 120 + 120*	0.09	0.09	0.09	0.11	0.09
140 + 140 + 140	0.09	0.09	0.09	0.10	0.09
<b>Kingspan Styrozone<sup>®</sup> H 350 R</b>					
80	X	X	X	X	X
100	0.25	0.25	0.25	X	0.25
120	0.21	0.21	0.21	0.23	0.21
140	0.20	0.20	0.20	0.21	0.20
160	0.17	0.17	0.17	0.19	0.17
100 + 80*	0.15	0.15	0.15	0.16	0.15
100 + 100	0.13	0.13	0.13	0.15	0.13
120 + 100*	0.12	0.12	0.12	0.14	0.12
120 + 120	0.11	0.11	0.11	0.13	0.11
140 + 120*	0.11	0.11	0.11	0.12	0.11
140 + 140	0.10	0.10	0.10	0.12	0.10
160 + 140*	0.10	0.10	0.10	0.11	0.10
160 + 160	0.09	0.09	0.09	0.11	0.09
120 + 120 + 100*	0.08	0.08	0.08	0.10	0.08

\* Where there are multiple layers of insulation of different thicknesses the thickest insulation board is installed first.

U-values (W/m <sup>2</sup> ·K) with Different Grades of Kingspan Styrozone <sup>®</sup> for a Nominal Selection of Post-Codes					
Insulant Thickness (mm)	Post-Code				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
<b>Kingspan Styrozone<sup>®</sup> N 300 R</b>					
120	X	X	X	X	X
140	0.25	0.25	0.25	X	0.25
160	0.22	0.22	0.22	0.24	0.22
180	0.21	0.21	0.21	0.22	0.21
100 + 100	0.18	0.18	0.18	0.19	0.18
120 + 100*	0.16	0.16	0.16	0.18	0.16
120 + 120	0.15	0.15	0.15	0.17	0.15
140 + 120*	0.14	0.14	0.14	0.16	0.15
140 + 140	0.13	0.13	0.13	0.15	0.14
160 + 140*	0.12	0.12	0.12	0.14	0.13
160 + 160	0.11	0.11	0.11	0.13	0.12
180 + 160*	0.11	0.11	0.11	0.13	0.12
180 + 180	0.11	0.11	0.11	0.12	0.12
140 + 120 + 120*	0.10	0.10	0.10	0.11	0.11
140 + 140 + 120*	0.09	0.09	0.09	0.11	0.10
140 + 140 + 140	0.09	0.09	0.09	0.10	0.10
<b>Kingspan Styrozone<sup>®</sup> H 350 R</b>					
100	X	X	X	X	X
120	0.22	0.22	0.22	0.24	0.22
140	0.21	0.21	0.21	0.22	0.21
160	0.18	0.18	0.18	0.20	0.18
100 + 80*	0.15	0.15	0.15	0.17	0.15
100 + 100	0.14	0.14	0.14	0.15	0.15
120 + 100*	0.13	0.13	0.13	0.14	0.14
120 + 120	0.12	0.12	0.12	0.13	0.13
140 + 120*	0.11	0.11	0.11	0.13	0.12
140 + 140	0.11	0.11	0.11	0.12	0.12
160 + 120*	0.10	0.10	0.10	0.12	0.11
160 + 160	0.09	0.09	0.09	0.11	0.10
120 + 120 + 100*	0.08	0.08	0.08	0.10	0.09

\* Where there are multiple layers of insulation of different thicknesses the thickest insulation board is installed first.

# Green Roofs

## Semi-intensive Green Roof Covering with No Ceiling

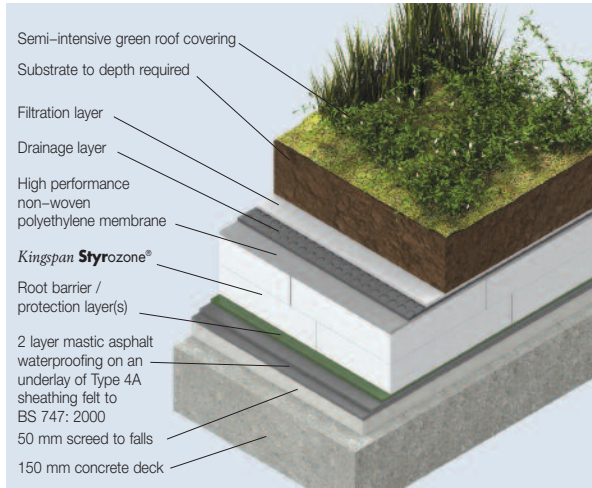


Figure 4

## Intensive Green Roof Covering with No Ceiling

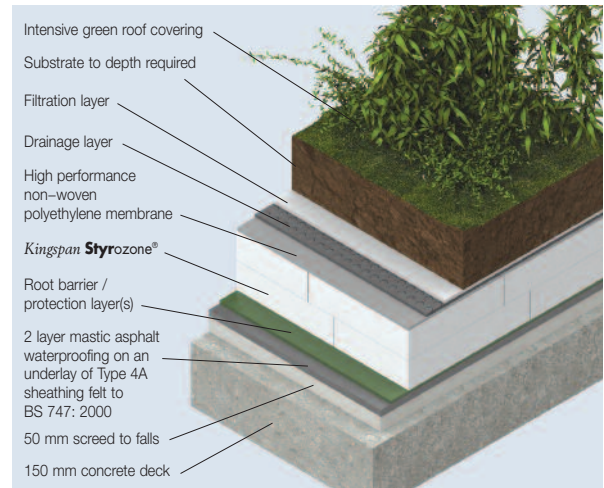


Figure 5

U-values (W/m <sup>2</sup> ·K) with Different Grades of Kingspan Styrozone® for a Nominal Selection of Post-Codes					
Insulant Thickness (mm)	Post-Code				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
<b>Kingspan Styrozone® N 300 R</b>					
120	X	X	X	X	X
140	0.25	0.25	0.25	X	0.25
160	0.22	0.22	0.22	0.24	0.22
180	0.21	0.21	0.21	0.22	0.21
100 + 100	0.18	0.18	0.18	0.19	0.18
120 + 100*	0.16	0.16	0.16	0.18	0.16
120 + 120	0.15	0.15	0.15	0.17	0.15
140 + 120*	0.14	0.14	0.14	0.16	0.15
140 + 140	0.13	0.13	0.13	0.15	0.14
160 + 140*	0.12	0.12	0.12	0.14	0.13
160 + 160	0.11	0.11	0.11	0.13	0.12
180 + 160*	0.11	0.11	0.11	0.13	0.12
180 + 180	0.11	0.11	0.11	0.12	0.12
140 + 120 + 120*	0.10	0.10	0.10	0.11	0.11
140 + 140 + 120*	0.09	0.09	0.09	0.11	0.10
140 + 140 + 140	0.09	0.09	0.09	0.10	0.10
<b>Kingspan Styrozone® H 350 R</b>					
100	X	X	X	X	X
120	0.22	0.22	0.22	0.24	0.22
140	0.21	0.21	0.21	0.22	0.21
160	0.18	0.18	0.18	0.20	0.18
100 + 80*	0.15	0.15	0.15	0.17	0.15
100 + 100	0.14	0.14	0.14	0.15	0.15
120 + 100*	0.13	0.13	0.13	0.14	0.14
120 + 120	0.12	0.12	0.12	0.13	0.13
140 + 120*	0.11	0.11	0.11	0.13	0.12
140 + 140	0.11	0.11	0.11	0.12	0.12
160 + 120*	0.10	0.10	0.10	0.12	0.11
160 + 160	0.09	0.09	0.09	0.11	0.10
120 + 120 + 100*	0.08	0.08	0.08	0.10	0.09

\* Where there are multiple layers of insulation of different thicknesses the thickest insulation board is installed first.

U-values (W/m <sup>2</sup> ·K) with Different Grades of Kingspan Styrozone® for a Nominal Selection of Post-Codes					
Insulant Thickness (mm)	Post-Code				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
<b>Kingspan Styrozone® N 300 R</b>					
120	X	X	X	X	X
140	0.25	0.25	0.25	X	0.25
160	0.22	0.22	0.22	0.24	0.22
180	0.21	0.21	0.21	0.22	0.21
100 + 100	0.18	0.18	0.18	0.19	0.18
120 + 100*	0.16	0.16	0.16	0.18	0.16
120 + 120	0.15	0.15	0.15	0.17	0.15
140 + 120*	0.14	0.14	0.14	0.16	0.15
140 + 140	0.13	0.13	0.13	0.15	0.14
160 + 140*	0.12	0.12	0.12	0.14	0.13
160 + 160	0.11	0.11	0.11	0.13	0.12
180 + 160*	0.11	0.11	0.11	0.13	0.12
180 + 180	0.11	0.11	0.11	0.12	0.12
140 + 120 + 120*	0.10	0.10	0.10	0.11	0.11
140 + 140 + 120*	0.09	0.09	0.09	0.11	0.10
140 + 140 + 140	0.09	0.09	0.09	0.10	0.10
<b>Kingspan Styrozone® H 350 R</b>					
100	X	X	X	X	X
120	0.22	0.22	0.22	0.24	0.22
140	0.21	0.21	0.21	0.22	0.21
160	0.18	0.18	0.18	0.20	0.18
100 + 80*	0.15	0.15	0.15	0.17	0.15
100 + 100	0.14	0.14	0.14	0.15	0.15
120 + 100*	0.13	0.13	0.13	0.14	0.14
120 + 120	0.12	0.12	0.12	0.13	0.13
140 + 120*	0.11	0.11	0.11	0.13	0.12
140 + 140	0.11	0.11	0.11	0.12	0.12
160 + 120*	0.10	0.10	0.10	0.12	0.11
160 + 160	0.09	0.09	0.09	0.11	0.10
120 + 120 + 100*	0.08	0.08	0.08	0.10	0.09

\* Where there are multiple layers of insulation of different thicknesses the thickest insulation board is installed first.

# Design Considerations

## Linear Thermal Bridging

Reasonable provision must be made to limit the effects of cold bridging. The design should ensure that roof-light or ventilator kerbs, gutters etc. are always insulated with the same thickness of insulation (*Kingspan Purlcrete*<sup>®</sup>chevron with a separate backing layer of *Kingspan Styrozone*<sup>®</sup>) as the general roof area. A *Kingspan Purlcrete*<sup>®</sup>chevron upstand should be used around the perimeter of the roof on the internal façade of parapets. A minimum distance of 300 mm should be maintained between the top of the insulation upstand and the bottom of the horizontal roof insulation. Wall insulation should also be carried up into parapets as high as the flat roof insulation upstand. Please contact the Kingspan Insulation Technical Service Department (see rear cover) for further advice.

## Sustainability & Responsibility

Kingspan Insulation has a long-term commitment to sustainability and responsibility: as a manufacturer and supplier of insulation products; as an employer; as a substantial landholder; and as a key member of its neighbouring communities.

A report covering the sustainability and responsibility of Kingspan Insulation Ltd's British operations is available at [www.kingspaninsulation.co.uk/sustainabilityandresponsibility](http://www.kingspaninsulation.co.uk/sustainabilityandresponsibility).

## Specification Clause

*Kingspan Styrozone*<sup>®</sup> should be described in specifications as:-

The roof insulation shall be *Kingspan Styrozone*<sup>®</sup> (insert grade) \_\_\_\_\_ mm thick: comprising high performance rigid extruded polystyrene insulation. The product shall be manufactured, with a blowing agent that has zero Ozone Depletion Potential (ODP), under a management control system certified to EN ISO 9001: 2000, and shall be installed in accordance with the instructions issued by Kingspan Insulation Limited.

## NBS Specifications

Details also available in NBS PLUS.

NBS users should refer to clause(s):

J21 440, J31 340, J41 440

(Standard and Intermediate)



## Protected Membrane Roofs

This literature describes the use of *Kingspan Styrozone*<sup>®</sup> as a component of protected membrane roofing systems using either a gravel or paving slab finish, and as a component of green roof systems.

Protected membrane roofing systems place the insulation above the waterproofing, and offer several advantages over traditional warm flat roofs.

- The waterproofing system can be expected to have a life in excess of that obtained in an exposed situation, as it is protected from mechanical damage, UV degradation from solar radiation and temperature extremes (both daily and seasonal).
- The roof is safe from condensation risk.
- The roof achieves an EXT.FAA fire rating with gravel ballast and paving slab protective finishes.
- Insulation can be lifted to allow inspection of the waterproofing system.
- Additional insulation can be added at a later date.
- The installation of the insulation is not weather dependant.

Rigid extruded polystyrene insulation has minimal water absorption, due to its closed cell structure, and is the only material suitable and approved for this application, where it will be subject to wetting / drying and freeze / thaw cycles.

## Product Selection

Consideration must be given to which *Kingspan Styrozone*<sup>®</sup> product is most appropriate for the required application.

A table of the key distinguishing features is shown below.

Product	Thermal Conductivity (W/m·K)	Density (kg/m <sup>3</sup> )	Compressive Strength at 10% Compression (kPa)
<i>Styrozone</i> <sup>®</sup> H 350 R	0.029 – 0.031	30	300
<i>Styrozone</i> <sup>®</sup> N 300 R	0.038 – 0.040	30	300

## Design Loads & Roof Structure

The suitability of the structure under consideration to accept design loads, including the increased dead load from ballast, snow and roof traffic, should be verified in accordance with BS 6399-3: 1988 (Loading for buildings. Code of practice for imposed roof loads).

The additional load from ballast can be considerable.

Ballast Layer	Dead Load
50 mm thick paving slabs	125 kg/m <sup>2</sup>
Gravel (16–32 mm diameter)	16 kg/m <sup>2</sup> per 10 mm depth
Soil (intensive green roof)	180 – 500 kg/m <sup>2</sup>
Soil (semi-intensive green roof)	120 – 200 kg/m <sup>2</sup>
Soil (extensive green roof)	60 – 150 kg/m <sup>2</sup>

The ballast layer resists wind uplift, prevents floatation of the boards after heavy rain, prevents UV degradation of the boards and gives the roof the required external fire performance.

## Wind Loads

The resistance of the waterproofing system, insulation and ballast to wind uplift should be assessed in accordance with BS 6399-2: 1997 (Loading for buildings. Code of practice for wind loads) or BS / I.S. EN 1991-1-4: 2005 (National Annex to Eurocode 1 Actions on structures. General Actions. Wind Actions). BRE Digest 295 gives specific design guidelines for loose-laid insulation systems.

For constructions located in sheltered exposure zones, or on buildings of up to 10 storeys, the self weight of a minimum 50 mm gravel ballast layer (minimum 80 kg/m<sup>2</sup>), installed over a non-woven polyethylene membrane, is generally sufficient to ensure that both the insulation boards and waterproofing system remain stable under the full design load.

For constructions located in moderate exposure zones, or on buildings of up to 10 to 15 storeys, this gravel ballast specification is generally sufficient, but the perimeter should be loaded with 50 mm thick paving slabs.

For severe exposure zones or tall buildings over 15 storeys, specialist advice should be sought. BRE Digest 311 (Wind scour of gravel ballast on roofs) should be used when a calculation is required for a specific building project.

## Flotation

The ballast specifications detailed in the 'Wind Loads' section (above) will be sufficient to prevent flotation of the insulation boards after heavy rain.

## Falls

The fall on a flat roof, constructed using **Kingspan Styrozone**<sup>®</sup>, is normally provided by the supporting structure being directed towards the rainwater outlets. The fall should be smooth and steep enough to prevent the formation of rainwater ponds. In order to ensure adequate drainage, BS 6229: 2003 (Flat roofs with continuously supported coverings. Code of practice) recommends uniform gradients of not less than 1 in 80. However, because of building settlement, it is advisable to design in even greater falls.

Protected membrane roofing systems incorporating **Kingspan Styrozone**<sup>®</sup> can be laid on roofs with a finished fall of less than 1:80, but the waterproofing system must be of a tanking specification.

## Design Details

### Paving Slab Ballasted Protected Membrane Roof Details

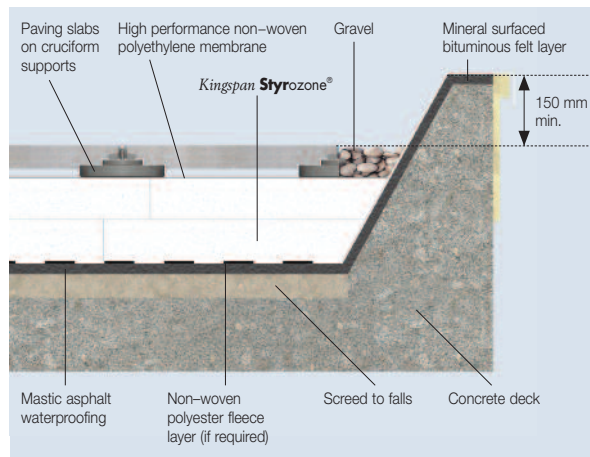


Figure 6 – Eave / Kerb Detail

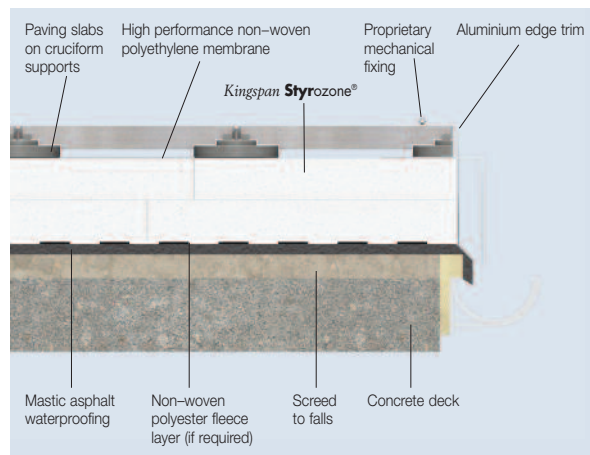


Figure 7 – Eave / Gutter Detail

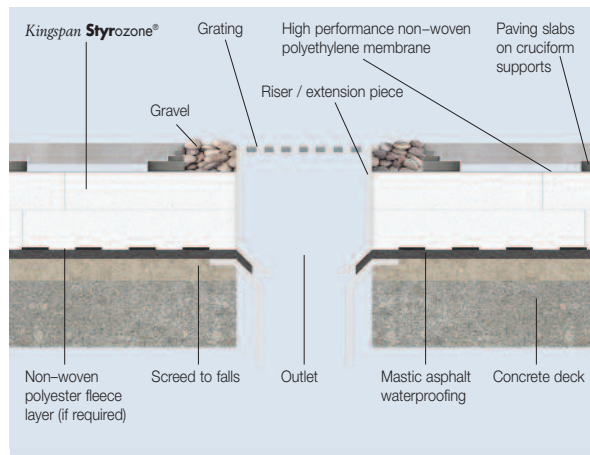


Figure 8 – Two Level Drainage

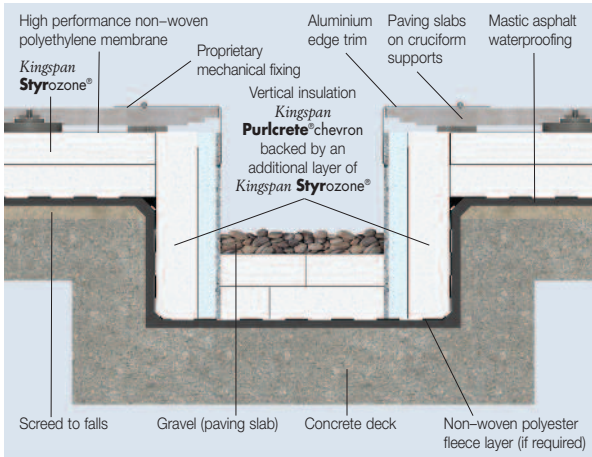


Figure 9 – Internal Gutter

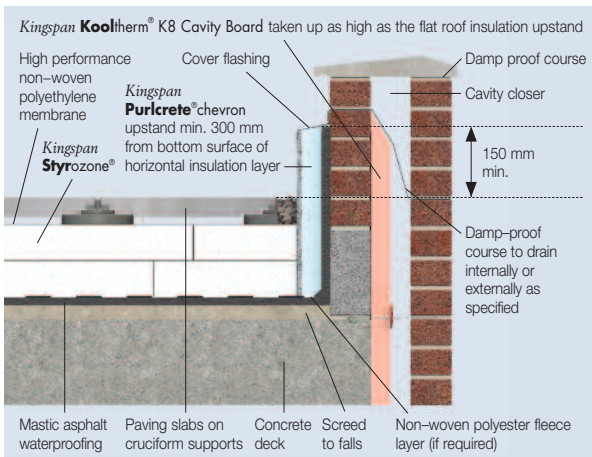


Figure 10 – Parapet Abutment

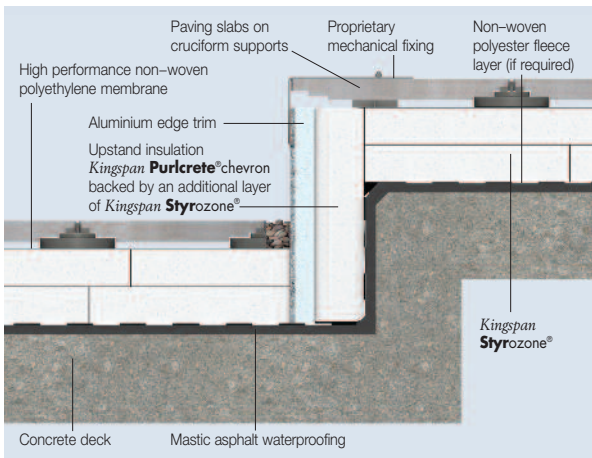


Figure 11 – Change in Level

## Rainfall Factors

The requirements of BS / I.S. EN ISO 6946: 2007 part D.4.2 (Correction due to water flowing beneath the insulation and the waterproofing membrane) dictate that inverted roof constructions are subject to a geographical rainfall analysis. The cooling effect of rainwater flowing between and beneath the insulation boards, can mean that greater thicknesses of insulation are required to meet desired U-values, particularly in locations that receive high levels of rainfall.

The use of a high performance non-woven polyethylene membrane over the insulation (see figs 6–11), can dramatically minimize heat loss by reducing the amount of rainwater that flows between and beneath the insulation boards.

This reduction in rainwater flow is represented by the infiltration (fx) factor of the membrane. The fx factor of a membrane is fall (gradient) specific, and an fx factor measured on a fall can not be used to represent the performance of a membrane if installed horizontally.

## Drainage

The number and type of rainwater outlets should be assessed in accordance with BS EN 12056-3: 2000 (Gravity drainage systems inside buildings. Roof drainage, layout and calculation). The rainwater outlets should be double entry type, to allow rainwater to be drained from the roof surface at both the membrane level and the upper surface level. When using paving slabs as ballast, on a roof with a finished fall of less than 1:80, they must be laid on supports, in order to aid drainage.

The drainage of green roofs should be carefully considered, especially in the case of intensive systems, which may require a moisture retention layer to ensure adequate moisture levels for the system but still allow the rapid drainage of excess rainwater. Dam type rainwater outlets that hold water in the system are not recommended, as the depth of water may create a moisture vapour impermeable layer above the insulation.

## Roof Waterproofing

*Kingspan Styrozone*<sup>®</sup> is suitable for use over some fully adhered single-ply waterproofing membranes.

*Kingspan Styrozone*<sup>®</sup> is also suitable for use over mastic asphalt waterproofing systems. Mastic asphalt waterproofing should be laid, where applicable, in accordance with BS 8218: 1998 (Code of practice for mastic asphalt roofing). Mastic asphalt should always be laid over an isolating layer of loose-laid Type 4A sheathing felt to BS 747: 2000 (Reinforced bitumen sheets for roofing. Specification).

*Kingspan Styrozone*<sup>®</sup> is also suitable for use over some hot and cold liquid applied waterproofing systems.

Mastic asphalt, some single-ply and some hot liquid applied waterproofing systems require a separation layer (non-woven polyester fleece layer, 130–140 g/m<sup>2</sup>, with an overlap of 250–300 mm) positioned between the membrane and the insulation.

Waterproofing systems containing solvents should be allowed to fully cure before installing *Kingspan Styrozone*<sup>®</sup> insulation.

## Water Vapour Control

Protected membrane roofs are inherently safe in respect of condensation risk. The roof design can be assessed for the risk of interstitial condensation using BS 5250: 2002 (Code of practice for control of condensation in buildings) or BS 6229: 2003 (Flat roofs with continuously supported coverings. Code of practice).

## Green Roofs

### Benefits

Green roofs, are an alternative to the standard protected membrane roof that offer many advantages but require precise design and detailing.

Specifically they can:

- reduce dust levels and improve humidity;
- provide a habitat for wildlife;
- create usable areas for recreational activities;
- retain rainfall thus prevent water surges into the drainage system;
- improve sound insulation; and
- provide a visually more attractive finish than protected membrane roofs with gravel or paving slab ballast.

### Types of Green Roof

Green roof systems can be divided into two main categories.

**Extensive green roofs** comprise a relatively shallow growing medium and low maintenance vegetation such as grass. They are lightweight, simple to design, construct and maintain, but should not be considered suitable for regular traffic or recreational activities. Extensive systems are especially useful in creating green areas for both ecological and aesthetic reasons.

**Semi-intensive green roofs** comprise a deeper growing medium and vegetation such as grass, perennials and shrubs. They are designed to be more garden-like and to accommodate limited access for maintenance and recreation.

**Intensive green roofs** have a much deeper growing medium and a wider variety of flora, including grass, shrubs and smaller trees. They are comparable with normal gardens in respect of maintenance, and can be used for recreation activities. The self weight of the system can be very high, due to the increased soil depth.

Careful design and detailing of both roof types is important and includes the following elements.

### Growing Medium

In its simplest form this is normal soil. Specialist mixtures are available, incorporating expanded clay and lava rock, which form the growing medium and have filtration, drainage and moisture retention functions.

### Drainage Layer

The drainage layer normally consists of either: a layer of washed gravel 8/16; expanded clay; or a specialist 'egg carton' or castellated plastic (HDPE) sheeting; all overlaid with a filtration membrane. The drainage layer allows the rapid removal of excess rainwater from the roof, thus avoiding saturation of the soil and the associated increase in weight.

### Moisture Retention Layer

The limited depth of soil, especially in the extensive type of roof, may require the use of a moisture retention layer to ensure sufficient water is available for the vegetation.

### Root Barrier

The roots of growing plants can seriously damage waterproof membranes, by growing into any small cracks, lap joints or other discontinuities. A root barrier may be formed by a separate cap sheet of polythene, or bitumen felt incorporating a thin copper film. The cap sheet is either adhered or loose-laid onto the waterproof membrane, with all joints sealed by bonding or welding, and must be continued up vertical faces of upstands.



# Sitework

## Waterproofing

- Prior to installing the insulation, it is essential to ensure that the waterproofing system has been installed correctly and that the roof is watertight and clean.
- Single-ply membranes, in particular, need careful attention to ensure that there has been no damage from following trades, and that puncturing from below the membrane (from nail heads or debris) cannot occur.
- If a single-ply membrane or mastic asphalt waterproofing system has been installed, a non-woven polyester fleece separation layer, with 250 – 300 mm overlaps, should be laid on top of the membrane prior to the installation of the insulation.

## Insulation Boards

- Start laying the *Kingspan Styrozone*<sup>®</sup> insulation boards from the point of access to the roof.
- Insulation boards should always be loose-laid break-bonded, either with their long edges at right angles to the edge of, or diagonally across the roof, and with joints lightly butted. There should be no gaps at abutments.
- If two or more layers of insulation are required, they should be horizontally offset relative to each other so that, as far as possible, the board joints in any two adjacent layers do not coincide with each other (see Figure 12).

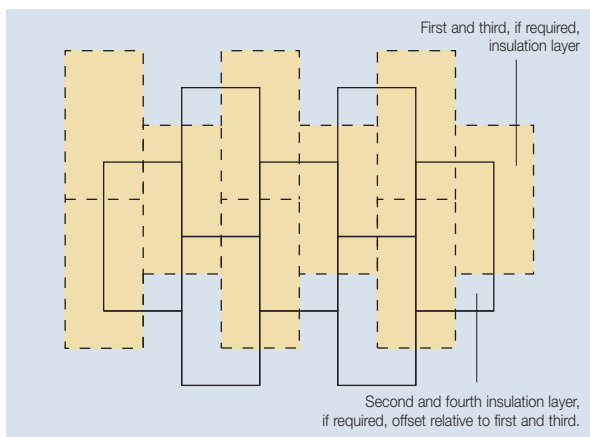


Figure 12 Offsetting of Multiple Insulation Layers

- Roof-light or ventilator kerbs, gutter etc. should always be insulated (*Kingspan Purlcrete*<sup>®</sup> chevron with a separate backing layer of *Kingspan Styrozone*<sup>®</sup>) to the same U-value as the general roof area.
- A *Kingspan Purlcrete*<sup>®</sup> chevron upstand should be used around the perimeter of the roof on the internal façade of parapets.
- A minimum distance of 300 mm should be maintained between the top of the insulation upstand and the bottom of the horizontal roof insulation.
- Boards can be laid in any weather but, due to the light weight of the boards, care must be taken in windy conditions.

## High Performance Non-Woven Polyethylene Membrane

- A high performance non-woven polyethylene membrane should be laid over the insulation boards.
- Where one run of the membrane laps another, there should be a minimum 300 mm side and end overlaps.
- The membrane should be turned up at the edge of the roof insulation and sealed under the flashing.

## Gravel Ballast

- Install the ballast layer as soon as possible, to ensure that the high performance non-woven polyethylene membrane is always protected and excessive heat build up or high winds do not damage the insulation boards.
- Gravel ballast should be washed, rounded, nominal 20–40 mm diameter, and of minimum depth 50 mm.
- The diameter of the gravel is important as this size has been found to be the most resistant to wind scour, BRE Digest 311 gives advice.

## Paving Slab Ballast

- Min. 50 mm thick paving slabs should be laid, over the high performance non-woven polyethylene membrane, on proprietary paving slab supports of minimum diameter 175 mm (or equivalent base area), in order to maintain drainage below the slabs, and to ensure that moisture vapour can escape.
- Install paving slabs and supports as soon as possible, to ensure that the high performance non-woven polyethylene membrane is always protected and excessive heat build up or high winds do not damage the insulation boards.
- Gaps between the paving slabs and upstands should be filled with washed, rounded gravel, nominal 20–40 mm diameter.

## Roof Gardens

- Having chosen the type of planting system and correctly detailed the various filter layers, moisture retention layers and growing medium, the installation, especially of extensive systems, is quick and simple.
- A root barrier (unless provided by the waterproofing layer) should be loose-laid on or bonded to the waterproofing membrane with all the laps sealed.
- The root barrier should be turned up at the edge of the roof insulation and sealed under the flashing.
- *Kingspan Styrozone*<sup>®</sup> should be installed as described previously.
- Boards should be overlaid with a high performance non-woven polyethylene membrane, which should be installed as described previously.

- A filtration layer or combined filtration layer / drainage mat is then installed, per its manufacturer's instructions.
- The growing medium, generally 50–200 mm deep is then installed. Specialist spray systems are available, which allow the application of growing medium and grass / plant seed to be applied in one operation.
- The depth of growing medium should be assessed for wind loads in accordance with BS 6399–2: 1997 (Loading for buildings. Code of practice for wind loads).

## General

### Cutting

- Cutting should be carried out either by using a fine toothed saw, or by scoring with a sharp knife and snapping the board over a straight edge.
- Ensure accurate trimming to achieve close-butting joints and continuity of insulation.

### Availability

- *Kingspan Styrozone*<sup>®</sup> is available through specialist insulation distributors and selected roofing merchants throughout the UK and Ireland.

### Packaging and Storage

- The polyethylene packaging of Kingspan Insulation products, which is recyclable, should not be considered adequate for outside protection.
- Ideally, boards should be stored inside a well ventilated building. If, however, outside storage cannot be avoided, then the boards should be stacked clear of the ground and covered with a pale pigmented polythene sheet or weatherproof tarpaulin.
- *Kingspan Styrozone*<sup>®</sup> should not be left in the sun covered by either a transparent or a dark plastic sheet, since in both cases, board temperatures can build up to a level hot enough to appreciably alter their dimensions or warp them.

### Health and Safety

- Kingspan Insulation products are chemically inert and safe to use.
- A Safety Information Data Sheet for this product is available from the Kingspan Insulation website [www.kingspaninsulation.co.uk/safety](http://www.kingspaninsulation.co.uk/safety) or [www.kingspaninsulation.ie/safety](http://www.kingspaninsulation.ie/safety).

*Warning – do not stand on or otherwise support your weight on this product unless it is fully supported by a load-bearing surface.*

# Product Details

## Composition

*Kingspan Styrozone*<sup>®</sup> H 350 R is a high performance rigid extruded polystyrene insulant manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and has a smooth, dense skin on both faces.



*Kingspan Styrozone*<sup>®</sup> N 300 R is a high performance rigid extruded polystyrene insulant manufactured with a blowing agent that has zero Ozone Depletion Potential (ODP) and low Global Warming Potential (GWP) and has a smooth, dense skin on both faces.

## Standards and Approvals

*Kingspan Styrozone*<sup>®</sup> is manufactured to the highest quality standards under a quality control system certified to EN ISO 9001: 2000 (Quality management systems. Requirements).

## Standard Dimensions

All products in the *Kingspan Styrozone*<sup>®</sup> range are available in the following standard size:

Nominal Dimension	Availability
Length (m)	1.25
Width (m)	0.6
Insulant Thickness (mm)	Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.
Edge Profile	Rebated

## Compressive Strength

The compressive strengths of *Kingspan Styrozone*<sup>®</sup> H 350 R and N 300 R typically exceed 300 kPa at 10% compression, when tested to EN 826: 1996 (Thermal insulating product for building applications. Determination of compression behaviour).

## Thermal Expansion

The linear thermal expansion coefficient of *Kingspan Styrozone*<sup>®</sup> is 0.07 mm/m·K.

## Water Vapour Resistivity

The boards achieve a resistivity greater than 825 MN·s/g·m, when tested in accordance with EN 12086: 1997 (Thermal insulating products for building applications. Determination of water vapour transmission properties).

## Absorption of Moisture

*Kingspan Styrozone*<sup>®</sup> is highly resistant to water absorption. It is very resistant to the passage of water vapour, and unaffected by repeated freeze / thaw cycles.

## Durability

If correctly installed, *Kingspan Styrozone*<sup>®</sup> can have an indefinite life. Its durability depends on the supporting structure and the conditions of its use.

## Resistance to Solvents, Fungi & Rodents

*Kingspan Styrozone*<sup>®</sup> is resistant to most commonly occurring construction materials such as lime, cement, plaster, anhydrous gypsum, solvent-free bituminous compounds, water-based wood preservatives, as well as alcohols, acids and alkalis. Certain organic materials such as solvent-based wood preservatives, coal tar and derivatives (creosote), paint thinners and common solvents (e.g. acetone, ethyl acetate, petrol, toluene and white spirit) will attack *Kingspan Styrozone*<sup>®</sup>, resulting in softening, shrinkage and possible dissolution, with a consequent loss of performance.

*Kingspan Styrozone*<sup>®</sup> does not provide any food value to vermin and is not normally attractive to them.

## Fire Performance

*Kingspan Styrozone*<sup>®</sup>, when subjected to the British Standard fire test specified in the table below, will achieve the result shown, when the surface finish is either minimum 50 mm gravel ballast or minimum 40 mm paving slabs. For specifications without the gravel ballast or paving slabs please consult the manufacturer of the specific external weatherproofing / ballast for their fire classification details.

Test	Result
BS 476-3: 2004 (External fire exposure roof test)	FAA rating

Further details on the fire performance of Kingspan Insulation products may be obtained from the Kingspan Insulation Technical Service Department (see rear cover).

## Maximum Service Temperature

*Kingspan Styrozone*<sup>®</sup> should not be brought into direct contact with high temperature heat sources. The maximum service temperature of *Kingspan Styrozone*<sup>®</sup> is 75°C.

## Thermal Properties

The  $\lambda$ -values and R-values detailed below are quoted in accordance with EN 13164: 2008 (Thermal insulation products for buildings – Factory made products of extruded polystyrene (XPS) – Specification).

### Thermal Conductivity

The boards achieve a thermal conductivity ( $\lambda$ -value) of *Kingspan Styrozone*<sup>®</sup> H 350 R is: 0.029 W/m·K (insulant thickness  $\leq$  120 mm); and 0.031 W/m·K (insulant thickness  $>$  120 mm).

*Kingspan Styrozone*<sup>®</sup> N 300 R is: 0.038 W/m·K (insulant thickness 100–160 mm); and 0.040 W/m·K (insulant thickness  $>$  160 mm).

### Thermal Resistance

Thermal resistance (R-value) varies with thickness and is calculated by dividing the thickness of the board (expressed in metres) by its thermal conductivity. The resulting number is rounded down to the nearest 0.05 (m<sup>2</sup>·K/W).

Insulant Thickness (mm)	Thermal Resistance (m <sup>2</sup> ·K/W)	
	H 350 R	N 300 R
80	2.75	–
100	3.40	2.60
120	4.10	3.15
140	4.50	3.65
160	5.15	4.20
180	–	4.50

NB Multiple layers of insulation are required for higher thermal resistances.

NB Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.

NB *Kingspan Styrozone*<sup>®</sup> may be delivered in packaging bearing alternative product branding.

# Contact Details

## Customer Service

For quotations, order placement and details of despatches please contact the Kingspan Insulation Customer Service Department on the numbers below:

UK	- Tel:	+44 (0) 1544 388 601
	- Fax:	+44 (0) 1544 388 888
	- email:	customerservice@kingspaninsulation.co.uk
Ireland	- Tel:	+353 (0) 42 979 5000
	- Fax:	+353 (0) 42 975 4299
	- email:	info@kingspaninsulation.ie

## Literature & Samples

Kingspan Insulation produces a comprehensive range of technical literature for specifiers, contractors, stockists and end users. The literature contains clear 'user friendly' advice on typical design; design considerations; thermal properties; sitework and product data.

Available as a complete Design Manual or as individual product brochures, Kingspan Insulation technical literature is an essential specification tool. For copies please contact the Kingspan Insulation Marketing Department, or visit the Kingspan Insulation website, using the details below:

UK	- Tel:	+44 (0) 1544 387 384
	- Fax:	+44 (0) 1544 387 484
	- email:	literature@kingspaninsulation.co.uk
	- www.kingspaninsulation.co.uk/literature	
Ireland	- Tel:	+353 (0) 42 979 5000
	- Fax:	+353 (0) 42 975 4299
	- email:	info@kingspaninsulation.ie
	- www.kingspaninsulation.ie/literature	

## Tapered Roofing

For technical guidance, quotations, order placement and details of despatches please contact the Kingspan Insulation Tapered Roofing Department on the numbers below:

UK	- Tel:	+44 (0) 1544 387 383
	- Fax:	+44 (0) 1544 387 483
	- email:	tapered@kingspaninsulation.co.uk
Ireland	- Tel:	+353 (0) 42 975 4297
	- Fax:	+353 (0) 42 975 4296
	- email:	tapered@kingspaninsulation.ie

## Technical Advice / Design

Kingspan Insulation supports all of its products with a comprehensive Technical Advisory Service for specifiers, stockists and contractors.

This includes a computer-aided service designed to give fast, accurate technical advice. Simply phone the Kingspan Insulation Technical Service Department with your project specification. Calculations can be carried out to provide U-values, condensation / dew point risk, required insulation thicknesses etc... Thereafter any number of permutations can be provided to help you achieve your desired targets.

The Kingspan Insulation Technical Service Department can also give general application advice and advice on design detailing and fixing etc... Site surveys are also undertaken as appropriate.

The Kingspan Insulation British Technical Service Department operates under a management system certified to the BBA Scheme for Assessing the Competency of Persons to Undertake U-value and Condensation Risk Calculations.



Please contact the Kingspan Insulation Technical Service Department on the numbers below:

UK	- Tel:	+44 (0) 1544 387 382
	- Fax:	+44 (0) 1544 387 482
	- email:	technical@kingspaninsulation.co.uk
Ireland	- Tel:	+353 (0) 42 975 4297
	- Fax:	+353 (0) 42 975 4296
	- email:	technical@kingspaninsulation.ie

## General Enquiries

For all other enquiries contact Kingspan Insulation on the numbers below:

UK	- Tel:	+44 (0) 1544 388 601
	- Fax:	+44 (0) 1544 388 888
	- email:	info@kingspaninsulation.co.uk
Ireland	- Tel:	+353 (0) 42 979 5000
	- Fax:	+353 (0) 42 975 4299
	- email:	info@kingspaninsulation.ie

*Kingspan Insulation Ltd. reserves the right to amend product specifications without prior notice. Product thicknesses shown in this document should not be taken as being available ex-stock and reference should be made to the current Kingspan Insulation price-list or advice sought from Kingspan Insulation's Customer Service Department (see above left). The information, technical details and fixing instructions etc. included in this literature are given in good faith and apply to uses described. Recommendations for use should be verified for suitability and compliance with actual requirements, specifications and any applicable laws and regulations. For other applications or conditions of use, Kingspan Insulation offers a Technical Advisory Service (see above), the advice of which should be sought for uses of Kingspan Insulation products that are not specifically described herein. Please check that your copy of this literature is current by contacting the Kingspan Insulation Marketing Department (see left).*



**Kingspan Insulation Ltd**  
Pembridge, Leominster, Herefordshire HR6 9LA, UK  
Castleblayney, County Monaghan, Ireland

[www.kingspaninsulation.co.uk](http://www.kingspaninsulation.co.uk) [www.kingspaninsulation.ie](http://www.kingspaninsulation.ie)

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