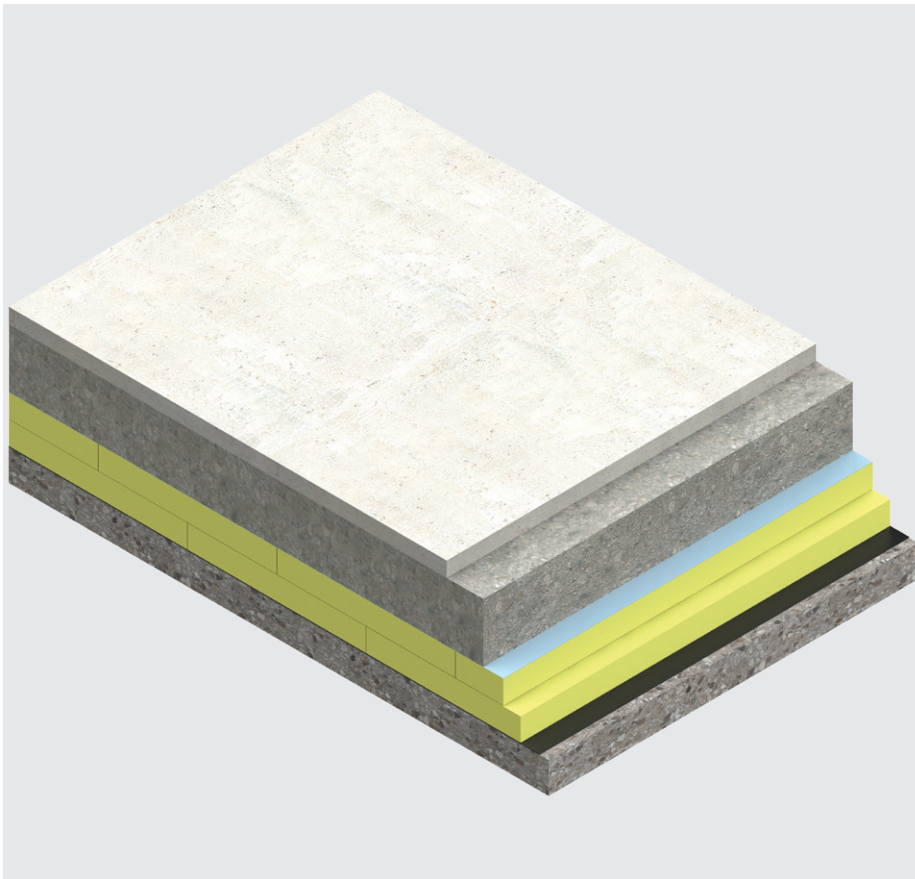


Kingspan **GreenGuard**[®] Heavy Duty Floors

Insulation for heavy duty commercial, industrial and cold store flooring



- Rigid extruded polystyrene insulation - thermal conductivities as low as 0.033 W/mK
- High compressive strength - available in a number of grades to suit a range of service loads
- Resistant to ground moisture penetration
- Unaffected by air infiltration
- Easy to handle and install compared to some other commonly used insulants
- Ideal for new build and refurbishment

Typical constructions and U-values

Assumptions

The U-values in the tables that follow have been calculated using the method detailed in BS EN ISO 13370: 2017 (Thermal performance of buildings. Heat transfer via the ground. Calculation methods), and using the conventions set out in BR 443 (Conventions for U-value calculations). They are valid for the constructions shown in the details immediately above each table.

Unlike roofs, walls and intermediate floors, U-value calculations for basement floors cannot be calculated with reference to the construction detail alone. Heat loss from basement floors depends upon the ratio of exposed floor perimeter to the total floor area, the thickness of the basement wall and depth of the basement.

Floor dimensions should be measured between the finished internal surfaces of the external walls. Non-usable heated space such as ducts and stairwells should be included when determining the area of the floor. Unheated spaces outside of the insulated fabric, such as attached garages or porches, should be excluded when determining the area of the floor, but the length of the wall between the heated building and the unheated space should be included when determining the perimeter. The floor dimensions of semi-detached, terraced or other joined premises / dwellings can be taken either as those of the premises / dwelling itself or those of the whole building. Where extensions to existing buildings are under consideration, the floor dimensions should be taken as those of the extension.

If the P/A ratio lies between two of the numbers shown in the tables to follow, for a safe estimate, please use the P/A ratio shown that is the next highest i.e. for 0.57 use 0.6.

For buildings with relatively small ground floor areas (primarily domestic properties), if the ground floor is left uninsulated, the thermal performance will be poor. To enhance the thermal performance, complete insulation of the ground floor should be adopted (Figure 1).

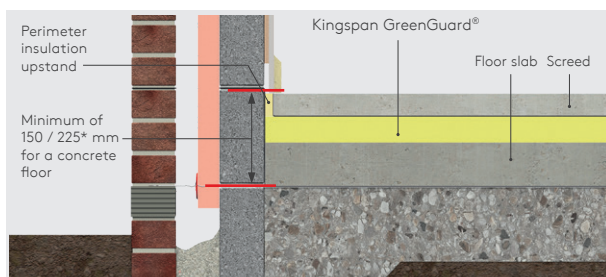


Figure 1 - Complete concrete floor insulation

For buildings with large ground floor areas, complete insulation of the ground floor may be unnecessary. Insulating the perimeter in a 1.2 metre wide strip may provide adequate thermal performance (Figure 2). For further advice on the width of the perimeter insulation please contact the Kingspan Insulation Technical Service Department.

Calculations in the tables that follow assume complete insulation of the floor area, please contact the Kingspan Insulation Technical Service Department for calculations with perimeter insulation only.

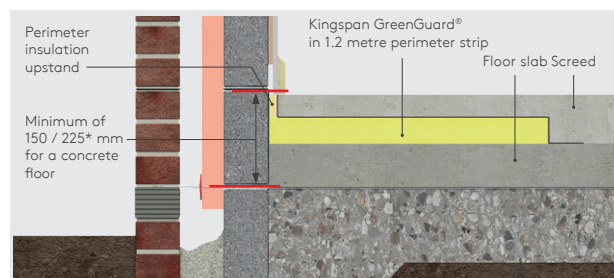


Figure 2 - Perimeter strip concrete floor insulation

NB The figures quoted are for guidance only. A detailed U-value calculation should be completed for each project.

NB For the purposes of these calculations, using the method as detailed in BS EN ISO 13370: 2017 / I.S. EN ISO 13370: 2007, the soil has been assumed to be sand or gravel, the wall insulation is assumed to overlap the floor insulation by minimum 150 / 225* mm, and the standard of workmanship has been assumed good, and therefore the correction factor for air gaps has been ignored.

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

NB These calculations were completed on the assumption that the insulation present in the floor construction is installed above the damp proof membrane, therefore declared thermal conductivity values were used.

NB For guidance regarding the routes to compliance for meeting the fire safety requirements of the Building Regulations / Standards, refer to the relevant Technical Bulletins and links to Government websites at www.kingspaninsulation.co.uk/fireregulations (for GB) or contact technical services at technical@kingspaninsulation.ie (for Ireland).

* 150 mm applies to the UK and 225 mm to the Republic of Ireland.

U-value table key

Further information on the applicable notional and area weighted average U-values is available in the relevant geographical documentation:

- Approved Documents L to the Building Regulations for England;
- Approved Documents L to the Building Regulations for Wales;
- Technical Handbooks Section 6 to the Building Standards for Scotland;
- Technical Booklets F1 & F2 to the Building Regulations for Northern Ireland; and
- Technical Guidance Document L (Dwellings) and Technical Guidance Document L (Buildings other than Dwellings) to the Building Regulations for the Republic of Ireland.

Typical constructions and U-values

Solid concrete ground floors

Medium compressive loads

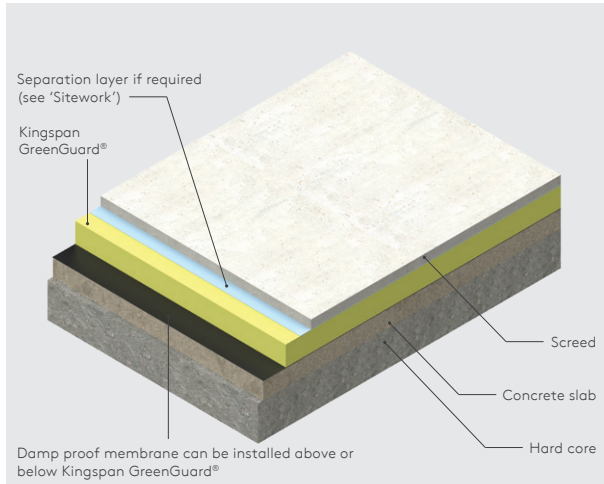


Figure 3

High to severe compressive loads

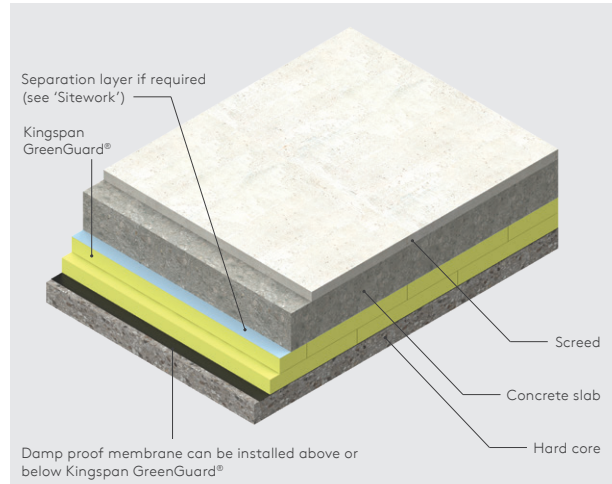


Figure 4

U-values (W/m ² K) for various thicknesses of Kingspan GreenGuard® GG300* and floor perimeter / area ratios					
Insulant thickness (mm)	Perimeter / area (m ⁻¹)				
	0.1	0.2	0.3	0.4	0.5
30	0.16	0.24	0.30	0.35	0.39
40	0.15	0.22	0.28	0.32	0.34
50	0.14	0.21	0.25	0.29	0.31
60	0.13	0.20	0.24	0.26	0.28
80	0.12	0.17	0.20	0.22	0.24
90 (50 + 40)	0.12	0.16	0.19	0.21	0.22
100	0.11	0.16	0.18	0.20	0.21
110 (60 + 50)	0.11	0.15	0.17	0.18	0.20
120	0.10	0.14	0.16	0.17	0.18
130 (80 + 50)	0.10	0.14	0.15	0.17	0.17
150	0.09	0.13	0.13	0.15	0.16
160 (80 + 80)	0.09	0.12	0.13	0.14	0.15
170 (120 + 50)	0.09	0.12	0.12	0.14	0.14
180	0.09	0.11	0.12	0.13	0.14
190 (150 + 40)	0.08	0.11	0.12	0.13	0.13
200 (100 + 100)	0.08	0.10	0.12	0.12	0.13
210 (150 + 60)	0.08	0.10	0.11	0.12	0.12
220 (120 + 100)	0.08	0.10	0.11	0.11	0.12
230 (150 + 80)	0.08	0.09	0.10	0.11	0.11
240 (120 + 120)	0.07	0.09	0.10	0.11	0.11
250 (150 + 100)	0.07	0.09	0.10	0.10	0.11
270 (150 + 120)	0.07	0.08	0.09	0.10	0.10
280 (100 + 180)	0.07	0.08	0.09	0.09	0.10
300 (150 + 150)	0.06	0.08	0.09	0.09	0.09
320 (100 + 100 + 120)	0.06	0.08	0.08	0.08	0.09
340 (100 + 120 + 120)	0.06	0.07	0.08	0.08	0.08
360 (180 + 180)	0.06	0.07	0.07	0.08	0.08

* The above table contains figures for Kingspan GreenGuard® GG300 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) or U-value Calculator for calculations for other products in the range.

NB Where multiple layers of insulation of different thicknesses are used, the thickest layer should be installed as the outermost layer in the construction.

NB If the insulation is installed below the damp proof membrane then design thermal conductivity values should be used for the purposes of U-value calculations.

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

U-values (W/m ² K) for various thicknesses of Kingspan GreenGuard® and floor perimeter / area ratios					
Insulant thickness (mm)	Perimeter / area (m ⁻¹)				
	0.1	0.2	0.3	0.4	0.5
Kingspan GreenGuard® GG500*					
50	0.17	0.25	-	-	-
80	0.15	0.21	0.24	-	-
100	0.14	0.18	0.21	0.23	0.24
130 (80 + 50)	0.12	0.16	0.17	0.19	0.20
150 (100 + 50)	0.11	0.14	0.16	0.17	0.18
160 (80 + 80)	0.11	0.14	0.15	0.16	0.17
180 (100 + 80)	0.10	0.13	0.14	0.15	0.16
200 (100 + 100)	0.10	0.12	0.13	0.14	0.14
230 (100 + 80 + 50)	0.09	0.11	0.12	0.12	0.13
260 (100 + 80 + 80)	0.08	0.10	0.11	0.11	0.12
270 (150 + 120)	0.08	0.10	0.10	0.11	0.11
280 (100 + 100 + 80)	0.08	0.09	0.10	0.11	0.11
300 (100 + 100 + 100)	0.08	0.09	0.10	0.10	0.10
Kingspan GreenGuard® GG700*					
60	0.16	0.23	-	-	-
80	0.15	0.20	0.23	-	-
100 (50 + 50)	0.13	0.18	0.20	0.22	0.24
120 (60 + 60)	0.12	0.16	0.18	0.20	0.21
140 (80 + 60)	0.12	0.15	0.17	0.18	0.18
160 (80 + 80)	0.11	0.14	0.15	0.16	0.17
180 (80 + 50 + 50)	0.10	0.13	0.14	0.15	0.15

* The above table contains figures for Kingspan GreenGuard® GG500 and Kingspan GreenGuard® GG700 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) or U-value Calculator for calculations for other products in the range.

NB Where multiple layers of insulation of different thicknesses are used, the thickest layer should be installed as the outermost layer in the construction.

NB If the insulation is installed below the damp proof membrane then design thermal conductivity values should be used for the purposes of U-value calculations.

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

Typical constructions and U-values

Heat loss and linear thermal bridging

Basic principles

Linear thermal bridging describes the heat losses that occur at junctions between elements, which is additional to the losses occurring through roofs, walls and floors. This heat loss is represented by the junction's psi (ψ) value. The lower the ψ -value, the better the performance of a junction detail. The ψ -values and lengths of linear thermal bridges are accounted for in whole building energy and carbon dioxide emissions calculations.

In a typical wall-to-ground floor junction the heat will flow through the easiest path, for example in a masonry cavity wall the linear thermal bridge is primarily the inner leaf of masonry and in a timber frame wall the linear thermal bridge is primarily the sole plate and the construction below it. These linear thermal bridges can be reduced by increasing the distance that the heat has to travel.

Approved details, such as the Accredited Construction Details (England & Wales / Scotland / Northern Ireland) and Acceptable Construction Details (Republic of Ireland), collectively referred to here as ACDs, can uplift performance to provide a clear starting point towards achieving compliance, but they are limited in scope and applicability. The greatest opportunity for mitigating the impact of linear thermal bridges can come from following accurately 'modelled' details that take into account the following design considerations.

Reducing linear thermal bridging

Detailing at junctions to minimise the effects of thermal bridging and the associated risk of condensation or mould growth is important and there are some simple design considerations that can be adopted to help mitigate the risks and to reduce heat losses.

- Care is required to ensure continuation of insulation wherever possible between the wall for best thermal performance. Where this is not possible, the insulation should be overlapped and ideally, insulation material introduced between.

- In order to minimise cold bridging at the edge of the floor, the distance between the top surface of the floor insulation or perimeter insulation upstand, and the bottom of the wall insulation must be a minimum of 150 / 225* mm for a concrete floor (see Figures 1 & 2). The further down the wall insulation extends past the floor insulation, the better the thermal performance of the junction between the wall and the floor.

* 150 mm applies to the UK and 225 mm to the Republic of Ireland.

- Perimeter upstand insulation helps to reduce heat losses from the junction between the floor and external walls. The upstand insulation helps to increase the distance that the heat has to travel in order to escape through the junction, which therefore helps to reduce heat loss. Omitting this, or using a poorer performing insulation, can increase these losses.
- Using better thermally performing 'lightweight' aggregate blockwork for the inner leaf of cavity walls in adjacency to the junction with the floor can assist with lowering heat losses from the junction.
- An internal lining of insulation on the warm side of the construction can help to reduce the heat losses through the junction. The internal lining could be a wall lining for the whole wall area, such as Kingspan Kooltherm® K118 Insulated Plasterboard, or could be localised insulation behind the plasterboard to help reduce a junction's losses.
- One of the best approaches to minimising cold bridging is use external wall insulation, making the whole wall and any junctions warm, with suitable wall insulation at the junction with the ground floor extending past the level of the floor insulation below ground level.

For further advice on details to reduce linear thermal bridging please contact the Kingspan Insulation Technical Service Department (see rear cover for details).

Design considerations

Responsible sourcing

Kingspan GreenGuard® GG300 and GG500 produced at Kingspan Insulation's Selby (North Yorkshire) manufacturing facility is certified to BES 6001 (Framework Standard for the Responsible Sourcing of Construction Products) 'Good'.



To download the certification, please visit our [website](#).

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 operations at its Pembridge (Herefordshire) and Selby (North Yorkshire) manufacturing facilities is available upon request from literature@kingspaninsulation.co.uk.

Specification clause

Kingspan GreenGuard® should be described in specification as:-

The floor insulation shall be Kingspan GreenGuard® GG300 / GG500 / GG700 (delete as appropriate) _____ mm thick: comprising rigid extruded polystyrene insulation. The product shall be manufactured under a management system certified to ISO 9001: 2015, ISO 14001: 2015, ISO 45001: 2018 and ISO 50001: 2018 and installed in accordance with the instructions issued by Kingspan Insulation Limited.

Product classifications

Uniclass UK

Pr_25_71_63_29 Extruded polystyrene (XPS) boards

CAWS

GG300, GG500 and GG700

E20/200, M10/290, M10/40, M13/260, M13/40

GG500

J42/12

GG700

K11/115, K11/125, K11/135, K11/145, K11/20, K11/215, K11/225, K11/235, K11/25, K11/295, M10/290, M10/40, M13/260, M13/40

Details also available at the [NBS Source](#).

Building Information Modelling (BIM)

BIM objects for Kingspan GreenGuard GG300, GG500 and GG700 can be downloaded using the Kingspan BIM Designer Software Tool available at: www.kingspaninsulation.co.uk.

Product selection

Un-reinforced floor screeds can be used in conjunction with Kingspan GreenGuard® in most applications. The high compressive strength of Kingspan GreenGuard® makes it particularly suitable for use where floor loads are to be severe.

Consideration must be given to which Kingspan GreenGuard® product is most appropriate for the required application. A table of the key distinguishing features is shown below.

Product	Thermal conductivity (W/mK)	Compressive strength (kPa)
Kingspan GreenGuard® GG300	0.033 W/mK (30 - 180 mm)	300
Kingspan GreenGuard® GG500	0.034 W/mK (50 mm) 0.036 W/mK (80 and 100 mm)	500
Kingspan GreenGuard® GG700	0.035 W/mK (50, 60 and 80 mm)	700

Design standards

Consideration should be given to the recommendations of BS 8102: 2022 (Code of practice for protection of structures against water from the ground), BS 8215: 1991 (Code of practice for design and installation of damp proof courses in masonry construction) and the information given in Building Research Establishment Digest 104 (Floor Screeds).

Compressive loads

Kingspan GreenGuard® GG300 is suitable for use in floors with low and medium service loads e.g. domestic and industrial flooring applications such as cold stores.

Kingspan GreenGuard® GG500 is particularly suited for use in industrial floor constructions with relatively high compressive service loads, such as car parks.

Kingspan GreenGuard® GG700 is particularly suited for use in floors with considerable service loads, such as aircraft hangers.

Sitework

Installation below a floor slab

- The site should be prepared and foundations, where appropriate, built to damp proof course (DPC) level.
- A thin sand blinding may be used to achieve a continuous level surface free from projections over rolled hardcore.
- The damp proof membrane (minimum 300 micron / 1200 gauge polythene) should be laid with joints well lapped and folded, to prevent the passage of ground water, either directly over the well compacted hardcore prior to laying the insulation boards, or over the insulation boards.
- The membrane should be brought up the surrounding foundation walls until it is sufficiently above the height of the wall DPC so that it will connect with or form the DPC.
- The insulation boards should always be loose-laid break-bonded, with joints lightly butted.
- 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 5).

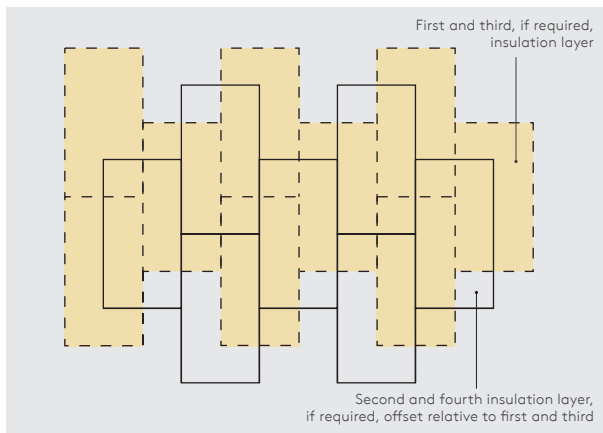


Figure 5 - Offsetting of multiple insulation layers

- A strip of rigid insulation board (minimum 20 mm thick) should be placed vertically around the perimeter of the floor slab in order to prevent cold bridging. The top of the strip of insulation board should be level with the top of the floor screed and the bottom should be level with the bottom of the horizontal floor insulation, and closely butted up to it.
- If the damp proof membrane is laid directly onto the hardcore below the insulation boards, the boards should be overlaid with a polythene sheet (not less than 125 micron / 500 gauge), to prevent the wet concrete penetrating the joints between the boards, and to act as a vapour control layer. Ensure the polythene sheet has 150 mm overlaps, taped at the joints, and is turned up 100 mm at the walls.
- The subsequent installation of the concrete slab and screed or other flooring material is carried out in a manner similar to that for an un-insulated floor. The concrete slab and screed should be allowed to dry out prior to the installation of the floor finish.

Installation below a floor screed

- Concrete slabs should be allowed to dry out fully prior to the installation of the insulation boards (average 1 day per mm of slab thickness).
- The surface of the slab should be smooth, flat and free from projections. Rough cast slabs should be levelled using a thin sand blinding to ensure boards are continuously supported.
- The damp proof membrane (minimum 300 micron / 1200 gauge polythene) should be laid with joints well lapped and folded, to prevent the passage of ground water, either directly over the floor slab prior to laying the insulation boards, or over the insulation boards.
- The membrane should be brought up the surrounding foundation walls until it is sufficiently above the height of the wall DPC so that it will connect with or form the DPC.
- The insulation boards should always be loose-laid break-bonded, with joints lightly butted.
- 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 5).
- A strip of rigid insulation board (minimum 20 mm thick) should be placed vertically around the perimeter of the floor slab in order to prevent cold bridging. The top of the strip of insulation board should be level with the top of the floor screed and the bottom should be level with the bottom of the horizontal floor insulation, and closely butted up to it.
- Insulation boards should be overlaid with a polythene sheet (not less than 125 micron / 500 gauge), to prevent the wet screed penetrating the joints between the boards, and to act as a vapour control layer. Ensure the polythene sheet has 150 mm overlaps, taped at the joints, and is turned up 100 mm at the walls.
- Use sand and cement screed laid to a minimum thickness of 75 mm.

Wheeled / foot traffic

- Ensure boards are protected during installation from wheeled / foot traffic by using scaffold planks or other protective measures.

Sitework

General

Cutting

- Cutting should be carried out either by using a fine toothed saw, a hot wire system 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 GreenGuard® is available through specialist insulation distributors and selected builders merchants throughout the UK and Ireland.

Packaging and storage

- Kingspan GreenGuard® may be delivered in packaging bearing alternative product branding.
- 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 GreenGuard® 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 or 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 GreenGuard® GG300, GG500 and GG700 are rigid extruded polystyrene insulants with a fibre-free core. They are manufactured with smooth, dense skins on both faces.



Standards and approvals

Kingspan GreenGuard® GG300 and GG500 are manufactured in accordance with the requirements of BS EN 13164: 2012 + A1: 2015 (Thermal insulation products for buildings. Factory made extruded polystyrene from (XPS) products. Specification).

Kingspan GreenGuard® GG300 and GG500 produced at Kingspan Insulation's Selby (North Yorkshire) manufacturing facility is manufactured to the highest standards under a management system certified to ISO 9001: 2015 (Quality management systems), ISO 14001: 2015 (Environmental Management Systems), ISO 45001: 2018 (Occupational Health and Safety Management Systems), ISO 50001: 2018 (Energy management systems) and ISO 37301: 2021 (Compliance management systems).

Standard dimensions

All products in the Kingspan GreenGuard® range are available in the following standard size:

Nominal dimension		Availability
Length	(mm)	1250 (and 2500 for GG300)
Width	(mm)	600
Insulant thickness	(mm)	Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.
Edge profile		Rebated (straight edge also available for GG300)

NB Please contact the Kingspan Insulation Technical Service Department (see rear cover) for information on rebated edge profiles.

Compressive strength

The declared compressive strength of Kingspan GreenGuard® products is as follows:

Kingspan GreenGuard® GG300 - 300 kPa;

Kingspan GreenGuard® GG500 - 500 kPa; and

Kingspan GreenGuard® GG700 - 700 kPa,

when tested to BS EN 826 (Thermal insulating products for building applications. Determination of compression behaviour).

Water vapour resistivity

The products typically achieve a resistivity greater than 400 MNs/gm, when tested in accordance with BS EN 12086: 2013 (Thermal insulating products for building applications. Determination of water vapour transmission properties).

Absorption of moisture

Kingspan GreenGuard® is highly resistant to water absorption and the effects of freeze-thaw cycling.

Durability

If correctly installed, Kingspan GreenGuard® can have an indefinite life. Its durability depends on the supporting structure and the conditions of its use.

Resistance to solvents, fungi & rodents

Kingspan GreenGuard® 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 GreenGuard®, resulting in softening, shrinkage and possible dissolution, with a consequent loss of performance.

Kingspan GreenGuard® does not provide any food value to vermin and is not normally attractive to them.

Fire performance

Under System 4 AVCP, Kingspan GreenGuard® G300, GG500 and GG700 have a Euroclass rating of F.

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 GreenGuard® should not be brought into direct contact with high temperature heat sources. The maximum service temperature of Kingspan GreenGuard® is 75°C.

Product details

Thermal properties

The λ -values and R-values detailed below are determined in accordance with BS EN 13164: 2012: + A1: 2015 (Thermal insulation products for buildings. Factory made extruded polystyrene (XPS) products. Specification).

Thermal conductivity

The boards achieve a thermal conductivity (λ -value) of:

Kingspan GreenGuard® GG300 is:

0.033 W/mK (insulant thickness 30 - 180 mm).

Kingspan GreenGuard® GG500 is:

0.034 W/mK (insulant thickness 50 mm); and

0.036 W/mK (insulant thickness 80 and 100 mm).

Kingspan GreenGuard® GG700 is:

0.035 W/mK (insulant thickness 50, 60 and 80 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 (m²K/W).

Insulant thickness (mm)	Thermal resistance (m ² K/W)		
	GG300	GG500	GG700
30	0.90	-	-
40	1.20	-	-
50	1.50	1.45	1.40
60	1.80	1.75	1.70
75	2.25	-	-
80	2.40	2.20	2.25
100	3.00	2.75	-
120	3.60	-	-
150	4.50	-	-
180	5.45	-	-

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 (manufactured thicknesses may vary between GB and IE).

NB Where a hyphen is shown the thickness is not available.

Contact details

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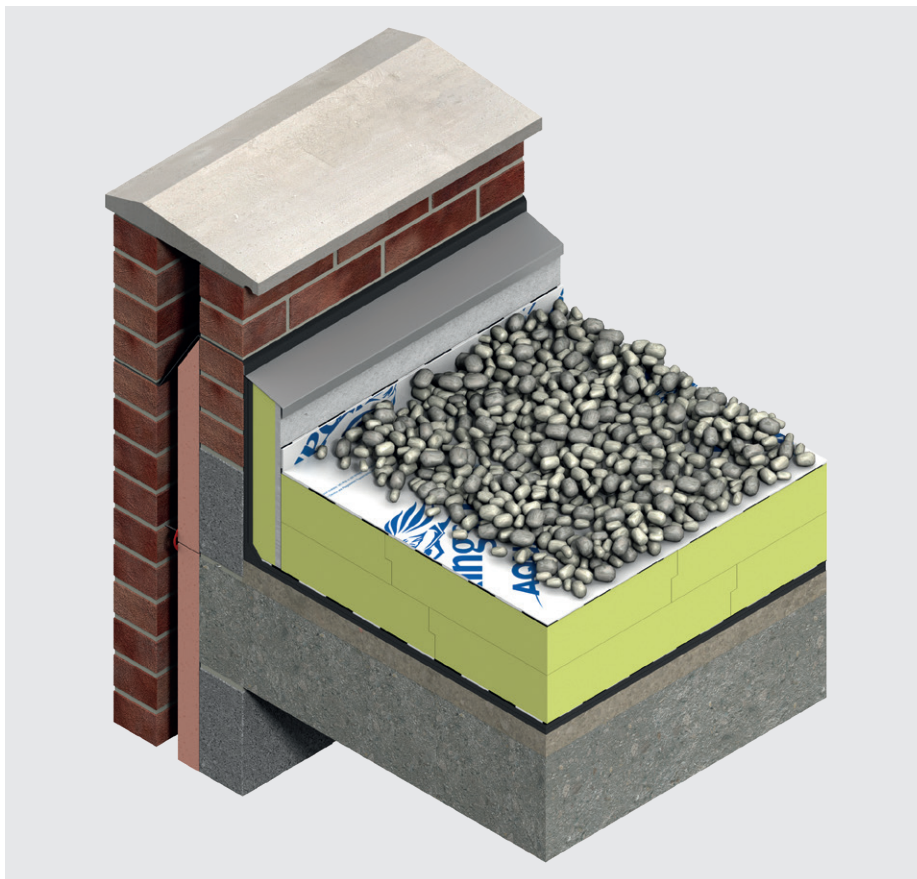
Registered in England & Wales, No. 01882722. Registered Office: Pembroke, Leominster, Herefordshire HR6 9LA UK. VAT GB428602456.

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Kingspan **GreenGuard**[®] Inverted Roofs

Insulation for protected membrane flat roofs and green roofs



- Rigid extruded polystyrene (XPS) insulation - declared thermal conductivities as low as 0.033 W/mK (0.035 W/mK design thermal conductivity)
- 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 compared to some other commonly used insulants
- Ideal for new build and refurbishment

Typical constructions and U-values

Assumptions

The U-values in the tables that follow have been calculated using the method detailed in BS EN ISO 6946: 2017 (Building components and building elements. Thermal resistance and thermal transmittance. Calculation methods), and using the conventions set out in BR 443 (Conventions for U-value calculations). The method detailed in part F.4.2 of BS EN ISO 6946: 2017 and D.4.2 of I.S. EN ISO 6946: 2007 has been used to take account of the effect of the Kingspan Aquazone® (high performance, non-woven polyethylene membrane) over the insulation, and an (fx) factor of 0.0012 for a paving slab ballast application or 0.0010 for a green roof or gravel ballast application, 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 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).

NB There are potential restrictions placed upon this product which vary dependant on building type, height, construction and location. For guidance regarding the routes to compliance for meeting the fire safety requirements of the Building Regulations / Standards, refer to the relevant Technical Bulletins and links to Government websites at www.kingspaninsulation.co.uk/fireregulations (for GB) or contact technical services at technical@kingspaninsulation.ie (for Ireland).

U-value table key

Further information on the applicable notional and area weighted average U-values is available in the relevant geographical documentation:

- Approved Documents L to the Building Regulations for England;
- Approved Documents L to the Building Regulations for Wales;
- Technical Handbooks Section 6 to the Building Standards for Scotland;
- Technical Booklets F1 & F2 to the Building Regulations for Northern Ireland; and
- Technical Guidance Document L (Dwellings) and Technical Guidance Document L (Buildings other than Dwellings) to the Building Regulations for the Republic of Ireland.

Concrete deck with paving slab ballast

Dense concrete deck with suspended ceiling

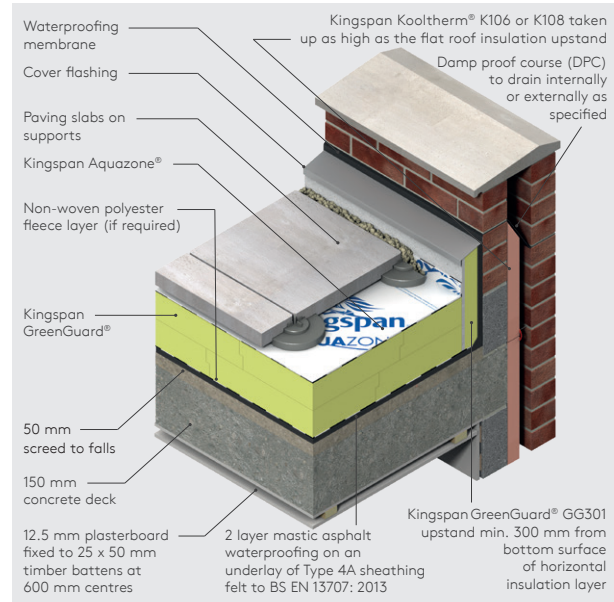


Figure 1

Insulation thickness (mm)	U-values (W/m²K) for a nominal selection of postcodes				
	Postcode				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
Kingspan GreenGuard® GG300*					
120	0.25	0.25	0.25	0.25	0.25
150	0.21	0.21	0.21	0.21	0.21
180	0.18	0.18	0.18	0.18	0.18
190 (150 + 40)	0.17	0.17	0.17	0.17	0.17
200 (100 + 100)	0.16	0.16	0.16	0.16	0.16
210 (150 + 60)	0.15	0.15	0.15	0.15	0.15
220 (120 + 100)	0.15	0.15	0.15	0.15	0.15
230 (150 + 80)	0.14	0.14	0.14	0.14	0.14
240 (120 + 120)	0.14	0.14	0.14	0.14	0.14
250 (150 + 100)	0.13	0.13	0.13	0.13	0.13
260 (100 + 100 + 60)	0.13	0.13	0.13	0.13	0.13
270 (150 + 120)	0.12	0.12	0.12	0.12	0.12
280 (180 + 100)	0.12	0.12	0.12	0.12	0.12
290 (150 + 100 + 40)	0.11	0.11	0.11	0.11	0.11
300 (150 + 150)	0.11	0.11	0.11	0.11	0.11
320 (100 + 100 + 120)	0.10	0.10	0.10	0.10	0.10
340 (100 + 120 + 120)	0.10	0.10	0.10	0.10	0.10
360 (180 + 180)	0.09	0.09	0.09	0.09	0.09
380 (100 + 100 + 180)	0.09	0.09	0.09	0.09	0.09
400 (150 + 150 + 100)	0.08	0.08	0.08	0.08	0.08

* The above table contains figures for Kingspan GreenGuard® GG300 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) for calculations for other products in the range.

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

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

Typical constructions and U-values

Concrete deck with gravel ballast

Dense concrete deck with suspended ceiling

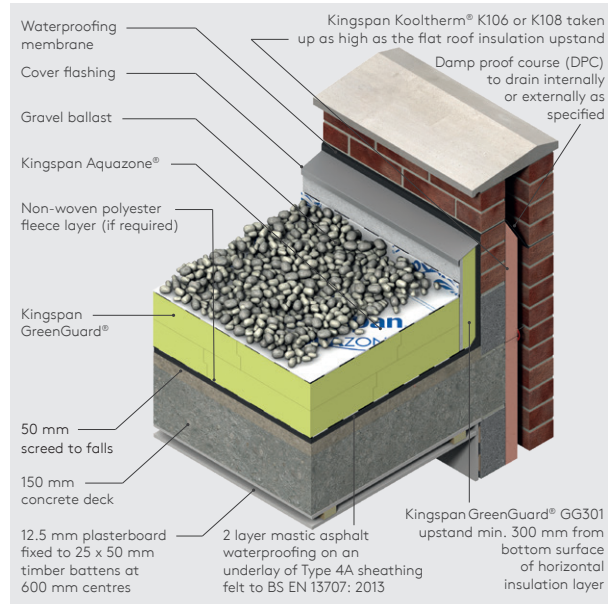


Figure 2

U-values (W/m ² K) for a nominal selection of postcodes					
Insulation thickness (mm)	Postcode				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
Kingspan GreenGuard® GG300*					
120	0.25	0.25	0.25	0.25	0.25
150	0.21	0.21	0.21	0.21	0.21
180	0.18	0.18	0.18	0.18	0.18
190 (150 + 40)	0.17	0.17	0.17	0.17	0.17
200 (100 + 100)	0.16	0.16	0.16	0.16	0.16
210 (150 + 160)	0.15	0.15	0.15	0.15	0.15
220 (120 + 100)	0.15	0.15	0.15	0.15	0.15
230 (150 + 80)	0.14	0.14	0.14	0.14	0.14
240 (120 + 120)	0.14	0.14	0.14	0.14	0.14
250 (150 + 100)	0.13	0.13	0.13	0.13	0.13
260 (100 + 100 + 60)	0.13	0.13	0.13	0.13	0.13
270 (150 + 120)	0.13	0.12	0.12	0.12	0.12
280 (180 + 100)	0.12	0.12	0.12	0.12	0.12
290 (150 + 100 + 40)	0.11	0.11	0.11	0.11	0.11
300 (150 + 150)	0.11	0.11	0.11	0.11	0.11
320 (100 + 100 + 120)	0.10	0.10	0.10	0.10	0.10
340 (100 + 120 + 120)	0.10	0.10	0.10	0.10	0.10
360 (180 + 180)	0.09	0.09	0.09	0.09	0.09
380 (100 + 100 + 180)	0.09	0.09	0.09	0.09	0.09
400 (150 + 150 + 100)	0.08	0.08	0.08	0.08	0.08

* The above table contains figures for Kingspan GreenGuard® GG300 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) for calculations for other products in the range.

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

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

Dense concrete deck with no ceiling

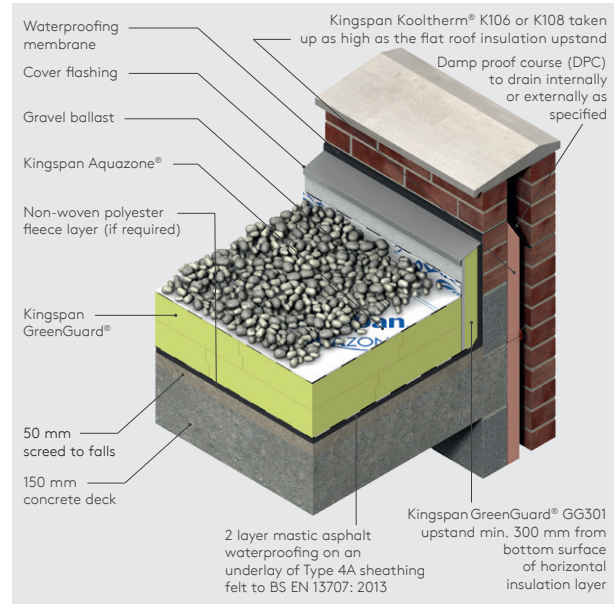


Figure 3

U-values (W/m ² K) for a nominal selection of postcodes					
Insulation thickness (mm)	Postcode				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
Kingspan GreenGuard® GG300*					
120	0.27	0.27	0.27	0.27	0.27
150	0.22	0.22	0.22	0.22	0.22
180	0.18	0.18	0.18	0.18	0.18
190 (150 + 40)	0.17	0.17	0.17	0.17	0.17
200 (100 + 100)	0.17	0.17	0.17	0.17	0.17
210 (150 + 160)	0.16	0.16	0.16	0.16	0.16
220 (120 + 100)	0.15	0.15	0.15	0.15	0.15
230 (150 + 80)	0.15	0.15	0.15	0.15	0.15
240 (120 + 120)	0.14	0.14	0.14	0.14	0.14
250 (150 + 100)	0.13	0.13	0.13	0.13	0.13
260 (100 + 100 + 60)	0.13	0.13	0.13	0.13	0.13
270 (150 + 120)	0.12	0.12	0.12	0.12	0.12
280 (180 + 100)	0.12	0.12	0.12	0.12	0.12
290 (150 + 100 + 40)	0.12	0.12	0.12	0.12	0.12
300 (150 + 150)	0.11	0.11	0.11	0.11	0.11
320 (100 + 100 + 120)	0.11	0.11	0.11	0.11	0.11
340 (100 + 120 + 120)	0.10	0.10	0.10	0.10	0.10
360 (180 + 180)	0.09	0.09	0.09	0.09	0.09
380 (100 + 100 + 180)	0.09	0.09	0.09	0.09	0.09
400 (150 + 150 + 100)	0.09	0.09	0.09	0.09	0.09

* The above table contains figures for Kingspan GreenGuard® GG300 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) for calculations for other products in the range.

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

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

Typical constructions and U-values

Green roofs

Semi-intensive green roof covering with no ceiling

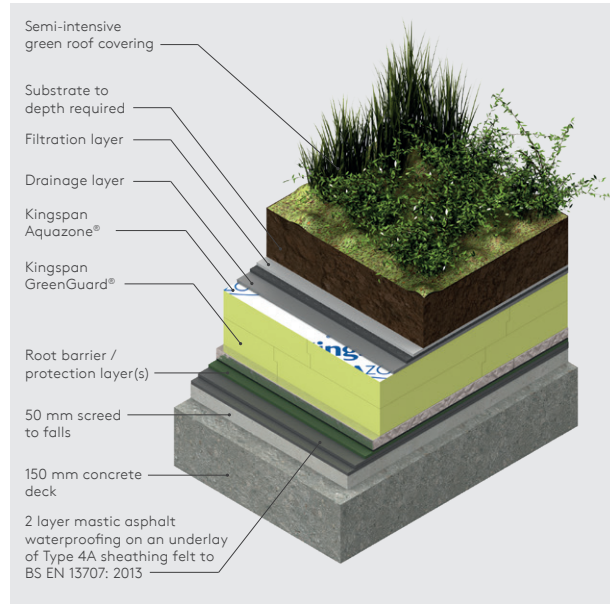


Figure 4

Intensive green roof covering with no ceiling

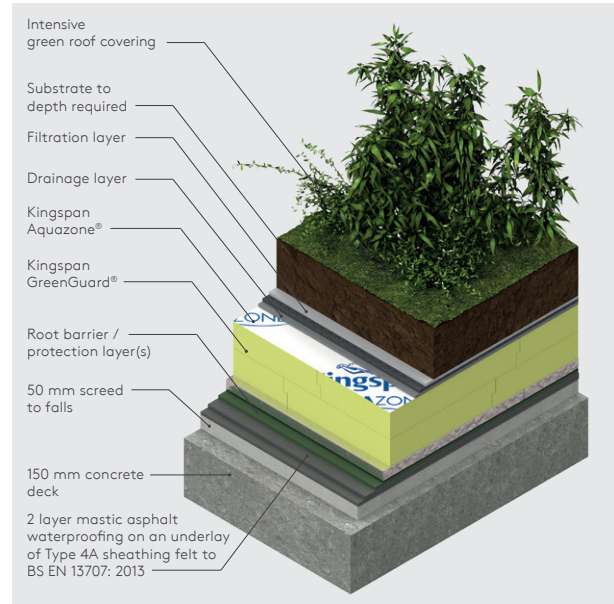


Figure 5

U-values (W/m ² K) for a nominal selection of postcodes					
Insulation thickness (mm)	Postcode				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
Kingspan GreenGuard® GG300*					
120	0.27	0.27	0.27	0.27	0.27
150	0.22	0.22	0.22	0.22	0.22
180	0.18	0.18	0.18	0.18	0.18
190 (150 + 40)	0.17	0.17	0.17	0.17	0.17
200 (100 + 100)	0.17	0.17	0.17	0.17	0.17
210 (150 + 160)	0.16	0.16	0.16	0.16	0.16
220 (120 + 100)	0.15	0.15	0.15	0.15	0.15
230 (150 + 80)	0.15	0.15	0.15	0.15	0.15
240 (120 + 120)	0.14	0.14	0.14	0.14	0.14
250 (150 + 100)	0.13	0.13	0.13	0.13	0.13
260 (100 + 100 + 60)	0.13	0.13	0.13	0.13	0.13
270 (150 + 120)	0.12	0.12	0.12	0.12	0.12
280 (180 + 100)	0.12	0.12	0.12	0.12	0.12
290 (150 + 100 + 40)	0.12	0.12	0.12	0.12	0.12
300 (150 + 150)	0.11	0.11	0.11	0.11	0.11
320 (100 + 100 + 120)	0.11	0.11	0.11	0.11	0.11
340 (100 + 120 + 120)	0.10	0.10	0.10	0.10	0.10
360 (180 + 180)	0.09	0.09	0.09	0.09	0.09
380 (100 + 100 + 180)	0.09	0.09	0.09	0.09	0.09
400 (150 + 150 + 100)	0.09	0.09	0.09	0.09	0.09

* The above table contains figures for Kingspan GreenGuard® GG300 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) for calculations for other products in the range.

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

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

U-values (W/m ² K) for a nominal selection of postcodes					
Insulation thickness (mm)	Postcode				
	London NW1	Birm'ham B1	Glasgow G1	Cardiff CF10	Ireland
Kingspan GreenGuard® GG300*					
120	0.27	0.27	0.27	0.27	0.27
150	0.22	0.22	0.22	0.22	0.22
180	0.18	0.18	0.18	0.18	0.18
190 (150 + 40)	0.17	0.17	0.17	0.17	0.17
200 (100 + 100)	0.17	0.17	0.17	0.17	0.17
210 (150 + 160)	0.16	0.16	0.16	0.16	0.16
220 (120 + 100)	0.15	0.15	0.15	0.15	0.15
230 (150 + 80)	0.15	0.15	0.15	0.15	0.15
240 (120 + 120)	0.14	0.14	0.14	0.14	0.14
250 (150 + 100)	0.13	0.13	0.13	0.13	0.13
260 (100 + 100 + 60)	0.13	0.13	0.13	0.13	0.13
270 (150 + 120)	0.12	0.12	0.12	0.12	0.12
280 (180 + 100)	0.12	0.12	0.12	0.12	0.12
290 (150 + 100 + 40)	0.12	0.12	0.12	0.12	0.12
300 (150 + 150)	0.11	0.11	0.11	0.11	0.11
320 (100 + 100 + 120)	0.11	0.11	0.11	0.11	0.11
340 (100 + 120 + 120)	0.10	0.10	0.10	0.10	0.10
360 (180 + 180)	0.09	0.09	0.09	0.09	0.09
380 (100 + 100 + 180)	0.09	0.09	0.09	0.09	0.09
400 (150 + 150 + 100)	0.09	0.09	0.09	0.09	0.09

* The above table contains figures for Kingspan GreenGuard® GG300 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) for calculations for other products in the range.

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

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

Design considerations

Linear thermal bridging

Basic principles

Linear thermal bridging describes the heat loss / gain that occurs at junctions between elements e.g. where an external wall meets the roof, or at junctions around openings in the building fabric where the thermal insulation layer is discontinuous e.g. sills, jambs and lintels.

Interruptions within the insulation layer by materials with poorer insulating properties can result in a thermal bridge, which in turn can lead to problems of condensation and mould growth, especially if there is a drop in surface temperature.

The heat flow at these junctions and opening locations, over and above that through the adjoining plane elements, is the linear thermal transmittance of the thermal bridge: measured in W/mK; referred to as a 'psi-value'; and expressed as a ' ψ -value'.

The lower the ψ -value, the better the performance. ψ -values are taken into account in the calculation methodologies e.g. the Standard Assessment Procedure (SAP), that are used to assess the operational CO₂ emissions and, where applicable, the fabric energy efficiency of buildings.

ψ -values can comprise either, or a combination of, approved, calculated or assumed values.

Reducing linear thermal bridging

Detailing at junctions to minimise the effects of thermal bridging and the associated risk of condensation or mould growth is important and there are some simple design considerations that can be adopted to help mitigate the risks and to reduce heat losses.

- Care is required to ensure continuation of insulation wherever possible between the wall and roof for best thermal performance. Where this is not possible, the roof and wall insulation should be overlapped and ideally, insulation material introduced between.
- Parapet detailing can represent a good, low heat loss approach, with insulation continuity maintained using an insulated upstand to reduce cold bridging. Kingspan GreenGuard® GG301 Upstand Board should be used around the perimeter of the roof on the internal façade of parapets. The upstand should extend a minimum of 150 mm above the roof insulation and achieve a minimum distance of 300 mm between the top of the insulation upstand and the bottom of the horizontal roof insulation. Wall insulation should be carried up into parapets at least as high as the flat roof insulation upstand.
- For best thermal performance, roof-lights and ventilator kerbs should be insulated with the same thickness of Kingspan GreenGuard® GG301, with a separate backing layer of Kingspan GreenGuard®, as the general roof area (see Figure 6).
- Where a parapet construction is not used, to achieve best performance, the roof insulation should overlap the wall to extend the thermal bridge path, if necessary by adding thermal insulation to edge beams to achieve continuity with external insulation (see Figure 7).
- Insulate internal rainwater downpipes and other pipes that penetrate the roof if they pass through spaces with a high humidity and if any condensate will damage the structure or internal finishes. Use Kingspan GreenGuard® around the pipe outlet and wrap joints with vapour resistant tape to restrict water vapour from reaching the pipe (see Figure 8).
- Where guttering is incorporated within a flat roof construction, this should be accounted for within the overall thermal design of the roof via an area-weighted calculation for the whole roof. The risk of localised interstitial condensation from reduced insulation provision at the gutter should be considered.
- Where an Internal gutter is formed, vertical insulation should be used to reduce thermal bridging, using Kingspan GreenGuard® GG301 with a separate backing layer of Kingspan GreenGuard® (see Figure 9). A similar approach can also reduce losses where a change in levels is required (see Figure 11).
- Lightweight aggregate blockwork to the inner leaf of wall constructions can help to improve thermal performance at junctions generally and where used for the inner leaf of parapet walls it can help to reduce losses (see Figure 10).

Design considerations

Responsible sourcing

Kingspan GreenGuard® GG300 and GG500 produced at Kingspan Insulation's Selby (North Yorkshire) manufacturing facility is certified to BES 6001 (Framework Standard for the Responsible Sourcing of Construction Products) 'Good'.



To download the certification, please visit our [website](#).

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 at its Pembridge (Herefordshire) and Selby (North Yorkshire) manufacturing facilities is available upon request from literature@kingspaninsulation.co.uk.

Specification clause

Kingspan GreenGuard® should be described in specifications as:-

The roof insulation shall be Kingspan GreenGuard® GG300 / GG500 (delete as appropriate) (insert grade) _____ mm thick: comprising rigid extruded polystyrene (XPS) insulation. The product shall be manufactured under a management system certified to ISO 9001: 2015, ISO 14001: 2015, ISO 45001: 2018, ISO 50001: 2018 and ISO 37301: 2021, and installed in accordance with the instructions issued by Kingspan Insulation Limited.

Product classifications

Uniclass UK

Pr_25_71_63_29 Extruded polystyrene (XPS) boards

CAWS

GG300 and GG700

J42/12

GG300, GG500 and GG700

J42/120, J42/415, J42/440, Q37/310

Details also available at the [NBS Source](#).

Protected membrane roofs

This literature describes the use of Kingspan GreenGuard® 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 the national requirements for external fire exposure when covered with an inorganic material i.e. 50 mm gravel or 40 mm paving slabs.
- 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 one of only a few materials 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 GreenGuard® product is most appropriate for the required application. A table of the key distinguishing features is shown below.

Product	Thermal conductivity (W/mK)	Compressive strength (kPa)
Kingspan GreenGuard® GG300	0.033 W/mK (30 - 180 mm)	300
Kingspan GreenGuard® GG500	0.034 W/mK (50 mm) 0.036 W/mK (80 and 100 mm)	500

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 EN 1991-1-3: 2003 + A1: 2015 (Eurocode 1. Actions on structures. General actions. Snow loads).

The additional load from ballast can be considerable.

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

The ballast layer resists wind uplift, prevents floatation of the boards after heavy rain and prevents UV degradation of the boards.

Design considerations

Wind loads

The resistance of the waterproofing system, insulation and ballast to wind uplift should be assessed in accordance with BS EN 1991-1-4: 2005 + A1: 2010 (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/m²), 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 GreenGuard®, 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: 2018 (Flat roofs with continuously supported flexible waterproof 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 GreenGuard® 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

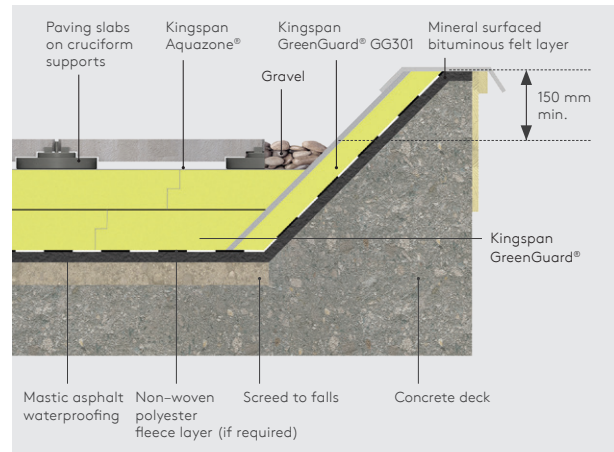


Figure 6 - Eave / kerb detail

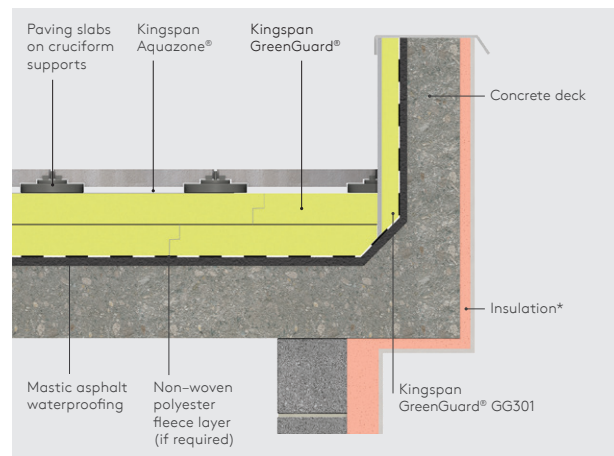


Figure 7 - Eave / gutter detail

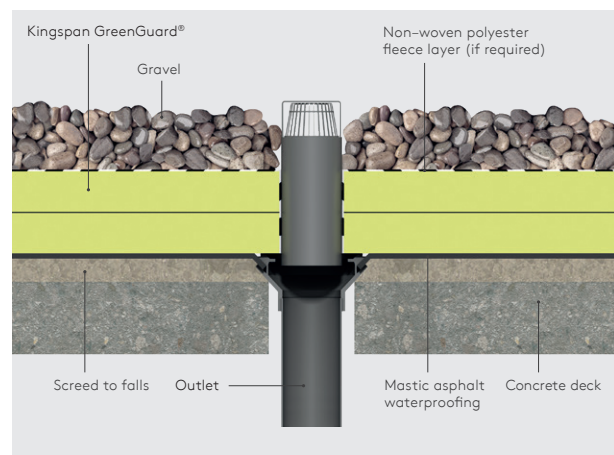


Figure 8 - Two level drainage

* The insulation specification will depend on the full build up and facade finish.

Design considerations

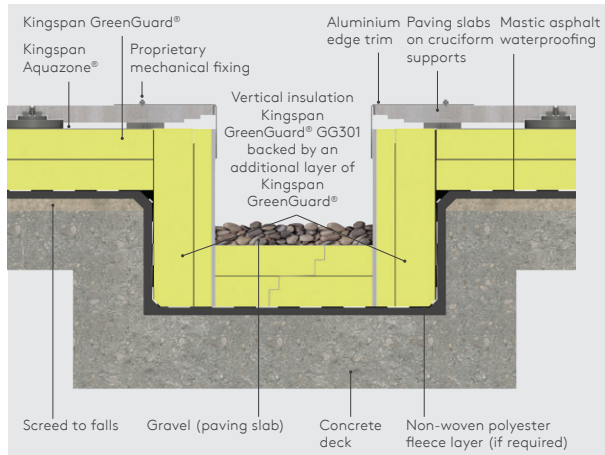


Figure 9 - Internal gutter

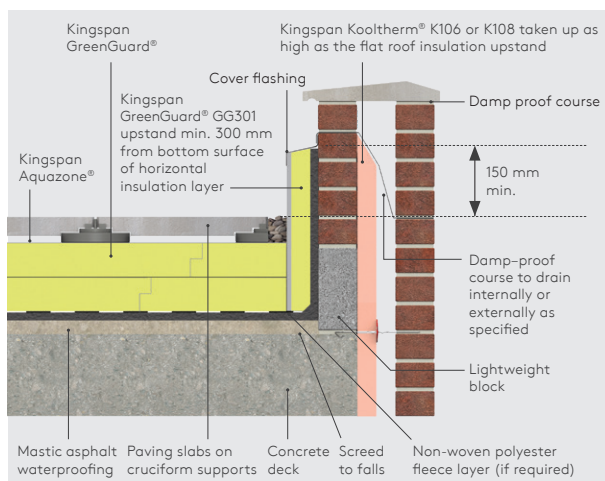


Figure 10 - Parapet abutment

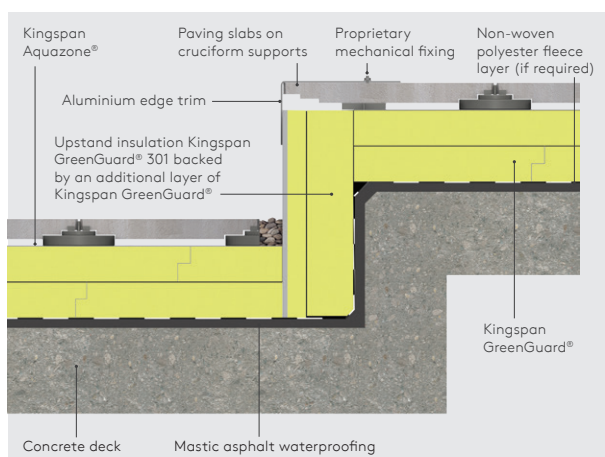


Figure 11 - Change in level

Rainfall factors

The requirements of part F.4.2 of BS EN ISO 6946: 2017 and D.4.2 of I.S. EN ISO 6946: 2007 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 Kingspan Aquazone® over the insulation (see Figures 6-11), can dramatically minimise 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.

Design considerations

Roof waterproofing

Kingspan GreenGuard® is suitable for use over some fully adhered single-ply waterproofing membranes.

Kingspan GreenGuard® 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 EN 13707: 2013 (Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing. Definitions and characteristics).

Kingspan GreenGuard® 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/m², 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 GreenGuard® 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: 2021 (Management of moisture in buildings. Code of practice) or BS 6229: 2018.

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;
- 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 three 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 all 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 GreenGuard® 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).

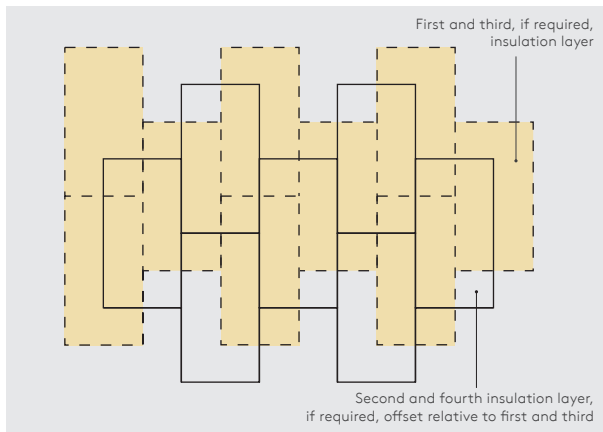


Figure 12 - Offsetting of multiple insulation layers

- Roof-light or ventilator kerbs, gutter etc. should always be insulated (Kingspan GreenGuard® GG301 with a separate backing layer of Kingspan GreenGuard®) to meet the same U-value as the general roof area.
- A Kingspan GreenGuard® GG301 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 boards being lightweight, care must be taken in windy conditions.

Kingspan Aquazone®

- Kingspan Aquazone®, 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 terminated flush with the paving slabs / ballast.

Gravel ballast

- Install the ballast layer as soon as possible, to ensure that Kingspan Aquazone® 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 Kingspan Aquazone®, 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 Kingspan Aquazone® 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.

Sitework

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 GreenGuard® should be installed as described previously.
- Boards should be overlaid with Kingspan Aquazone®, 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 EN 1991-1-4: 2005 + A1: 2010 (Eurocode 1. Actions on structures. General actions. Wind actions). BRE Digest 295 gives specific design guidelines for loose-laid insulation systems.

Mechanical fixings (Kingspan GreenGuard® GG301 only)

- Cutting Kingspan GreenGuard® GG301 should be carried out by using a TCT saw. Ensure correct FFP2 or 3 grade PPE is used to protect against inhalation of dust during cutting.
- A minimum of 3 fixings, with a minimum head diameter of 25 mm, are required to secure 1200 mm long boards of Kingspan GreenGuard® GG301 to the parapet.
- The requirement for additional fixings should be assessed in accordance with BS EN 1991-1-4: 2005 + A1: 2010 (National Annex to Eurocode 1. Actions on structures. General Actions. Wind Actions).
- Mechanical fixings must be arranged in an even pattern.
- Fixings for Kingspan GreenGuard® GG301 should be positioned across the top edge of the board and at a maximum of 600 mm centres.
- Fixings at insulation board edges must be located > 50 mm and < 200 mm from edges and corners of the board and not overlap board joints.
- Each fixing should incorporate a square or circular plate washer (minimum 25 x 25 mm or 25 mm diameter).
- Fixings should be driven straight.
- Care should be taken not to overdrive fixings.
- The bottom of the board should be supported and held in place by the Kingspan GreenGuard® and ballast / paving slabs on supports.

- Additional fixings should be used if the Kingspan GreenGuard® GG301 is not supported, following the same specification as detailed in the previous bullet point.

- For details on fixings refer to:

Ejot UK Limited +44 (0) 1977 687 040
www.mejot.co.uk

Fixfast +44 (0) 1732 882 387
www.fixfast.com

MAK Fasteners +353 (0) 1 451 9004
www.makfasteners.com

SFS Intec +44 (0) 1132 085 500
www.sfsintec.biz/uk

General

Cutting

- Cutting should be carried out either by using a fine toothed saw, a hot wire system 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 GreenGuard® is available through specialist insulation distributors and selected builders merchants throughout the UK and Ireland.

Packaging and storage

- Kingspan GreenGuard® may be delivered in packaging bearing alternative product branding.
- 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 GreenGuard® 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 or
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 GreenGuard® GG300 and GG500 are rigid extruded polystyrene insulants with a fibre-free core. They are manufactured with a smooth, dense skin on both faces.



Standards and approvals

Kingspan GreenGuard® GG300 and GG500 are manufactured in accordance with the requirements of BS EN 13164: 2012 + A1: 2015 (Thermal insulation products for buildings. Factory made extruded polystyrene from (XPS) products. Specification).

Kingspan GreenGuard® GG300 and GG500 produced at Kingspan Insulation's Selby (North Yorkshire) manufacturing facility is manufactured under a management system certified to ISO 9001: 2015 (Quality management systems), ISO 14001: 2015 (Environmental Management Systems), ISO 45001: 2018 (Occupational Health and Safety Management Systems), ISO 50001: 2018 (Energy management systems) and ISO 37301: 2021 (Compliance management systems).

The use of Kingspan GreenGuard GG300 in inverted roofs, excluding green roofs and roof garden applications (in thicknesses of 30, 40, 50, 60, 70, 80, 100, 120, 140, 150 and 180 mm) is covered by BBA Certificate 22/6048.



Standard dimensions

All products in the Kingspan GreenGuard® range are available in the following standard size:

Nominal dimension		Availability
Length	(mm)	1250
Width	(mm)	600
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 declared compressive strength of Kingspan GreenGuard® products is as follows:

Kingspan GreenGuard® GG300 – 300 kPa; and
Kingspan GreenGuard® GG500 – 500 kPa,

when tested to BS EN 826 (Thermal insulating products for building applications. Determination of compression behaviour).

Water vapour resistivity

The products typically achieve a resistivity greater than 400 MN/gm, when tested in accordance with BS EN 12086: 2013 (Thermal insulating products for building applications. Determination of water vapour transmission properties).

Absorption of moisture

Kingspan GreenGuard® is highly resistant to water absorption and the effects of freeze-thaw cycling.

Durability

If correctly installed, Kingspan GreenGuard® can have an indefinite life. Its durability depends on the supporting structure and the conditions of its use.

Resistance to solvents, fungi & rodents

Kingspan GreenGuard® 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 GreenGuard®, resulting in softening, shrinkage and possible dissolution, with a consequent loss of performance.

Kingspan GreenGuard® does not provide any food value to vermin and is not normally attractive to them.

Fire performance

Under System 4 AVCP, Kingspan GreenGuard® GG300 and GG500 have a Euroclass rating of F.

Roof covering products (and/or materials) defined in Commission Decision 2000/553/ EC of 6 September 2000, implementing Council Directive 89/106/EEC, can be considered to fulfil all of the requirements for the performance characteristic 'external fire performance' without the need for testing, provided that any national provisions on the design and execution of works are fulfilled, and can be used without restriction. This applies to products intended to be fully covered in normal usage by the inorganic coverings listed below.

- Loose laid gravel with a thickness of at least 50 mm or a mass $\geq 80 \text{ kg/m}^2$ (minimum aggregate size 4 mm, maximum 32 mm).
- Sand/cement screed to a thickness of at least 30 mm.
- Cast stone or mineral slabs of at least 40 mm thickness.

For other configurations of coverings, please contact the system supplier.

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 GreenGuard® should not be brought into direct contact with high temperature heat sources. The maximum service temperature of Kingspan GreenGuard® is 75°C.

Product details

Thermal properties

The λ -values and R-values detailed below are quoted in accordance with BS EN 13164: 2012: + A1: 2015 (Thermal insulation products for buildings. Factory made extruded polystyrene foam (XPS) products. Specification).

Declared thermal conductivity

The boards achieve a declared thermal conductivity (λ -value) of:

Kingspan GreenGuard® GG300 is:

0.033 W/mK (insulant thickness 30 - 180 mm).

Kingspan GreenGuard® GG500 is:

0.034 W/mK (insulant thickness 50 mm); and

0.036 W/mK (insulant thickness 80 and 100 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 (m²K/W).

Insulant thickness (mm)	Thermal resistance (m ² K/W)	
	GG300	GG500
30	0.90	-
40	1.20	-
50	1.50	1.45
60	1.80	1.75
75	2.25	-
80	2.40	2.20
100	3.00	2.75
120	3.60	-
150	4.50	-
180	5.45	-

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 (manufactured thicknesses may vary between GB and IE).

NB Where a hyphen is shown the thickness is not available.

Design thermal conductivity

In applications where Kingspan GreenGuard® could come into contact with moisture, a design thermal conductivity is taken into account within U-value calculations. The boards achieve a design thermal conductivity (λ -value) of:

Kingspan GreenGuard® GG300 is:

0.035 W/mK (insulant thickness 30 - 180 mm).

Kingspan GreenGuard® GG500 is:

0.036 W/mK (insulant thickness 50 mm); and

0.038 W/mK (insulant thickness 80 and 100 mm).

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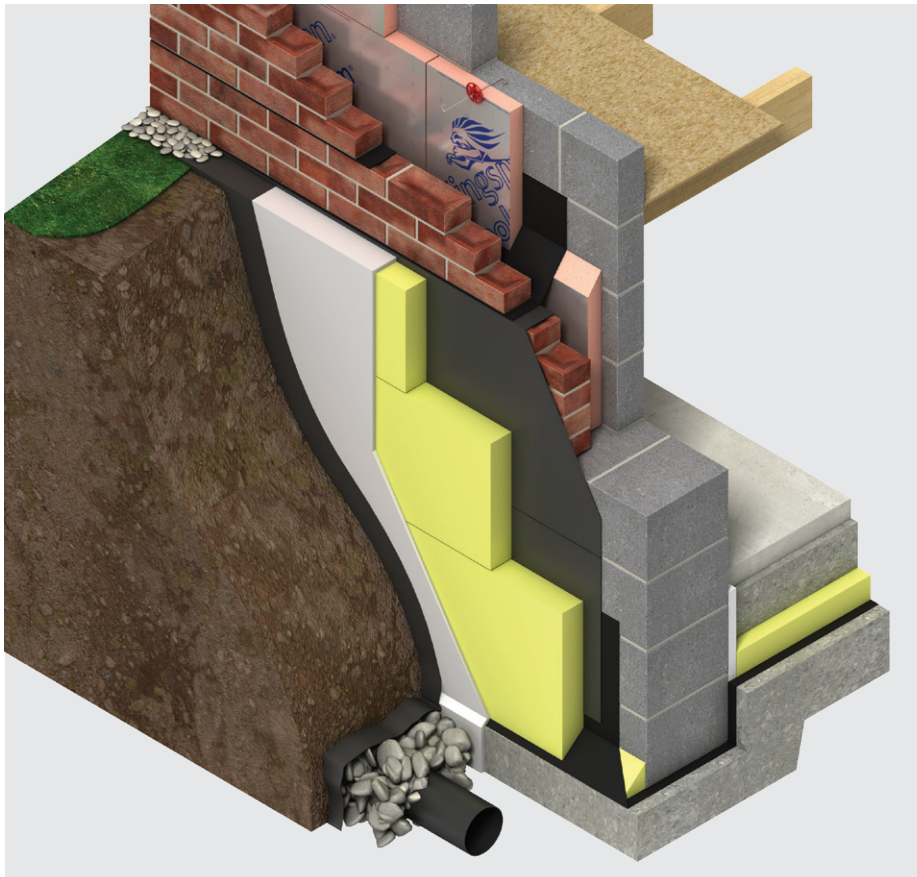
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Kingspan **GreenGuard**[®] Basements

Insulation for basements



- Rigid extruded polystyrene insulation - thermal conductivities as low as 0.033 W/mK
- High compressive strength
- Resistant to ground moisture penetration
- Unaffected by air infiltration
- Easy to handle and install compared to some other commonly used insulants
- Ideal for new build and refurbishment

Typical constructions and U-values

Assumptions

The U-values in the tables that follow have been calculated using the method detailed in BS EN ISO 13370: 2017 (Thermal performance of buildings. Heat transfer via the ground. Calculation methods), and using the conventions set out in BR 443 (Conventions for U-value calculations). They are valid for the constructions shown in the details immediately above each table. These examples assume that the basement walls are 300 mm thick and the height of the basement walls are 2.5 m.

Unlike roofs, walls and intermediate floors, U-value calculations for basement floors cannot be calculated with reference to the construction detail alone. Heat loss from basement floors depends upon the ratio of exposed floor perimeter to the total floor area, the thickness of the basement wall and depth of the basement.

Floor dimensions should be measured between the finished internal surfaces of the external walls. Non-usable heated space such as ducts and stairwells should be included when determining the area of the floor. Unheated spaces outside of the insulated fabric, such as attached garages or porches, should be excluded when determining the area of the floor, but the length of the wall between the heated building and the unheated space should be included when determining the perimeter. The floor dimensions of semi-detached, terraced or other joined premises / dwellings can be taken either as those of the premises / dwelling itself or those of the whole building. Where extensions to existing buildings are under consideration, the floor dimensions should be taken as those of the extension.

If the P/A ratio lies between two of the numbers shown in the tables to follow, for a safe estimate, please use the P/A ratio shown that is the next highest i.e. for 0.57 use 0.6.

NB The figures quoted are for guidance only. A detailed U-value calculation should be completed for each project.

NB For the purposes of these calculations, using the method as detailed in BS EN ISO 13370: 2017 / I.S. EN ISO 13370: 2007, the soil has been assumed to be sand or gravel, the wall insulation is assumed to overlap the floor insulation by minimum 150 / 225* mm, and the standard of workmanship has been assumed good, and therefore the correction factor for air gaps has been ignored.

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

NB These calculations were completed on the assumption that the insulation present in the floor construction is installed above the damp proof membrane, therefore declared thermal conductivity values were used.

NB For guidance regarding the routes to compliance for meeting the fire safety requirements of the Building Regulations / Standards, refer to the relevant Technical Bulletins and links to Government websites at www.kingspaninsulation.co.uk/fireregulations (for GB) or contact technical services at technical@kingspaninsulation.ie (for Ireland).

* 150 mm applies to the UK and 225 mm to the Republic of Ireland.

U-value table key

Further information on the applicable notional and area weighted average U-values is available in the relevant geographical documentation:

- Approved Documents L to the Building Regulations for England;
- Approved Documents L to the Building Regulations for Wales;
- Technical Handbooks Section 6 to the Building Standards for Scotland;
- Technical Booklets F1 & F2 to the Building Regulations for Northern Ireland; and
- Technical Guidance Document L (Dwellings) and Technical Guidance Document L (Buildings other than Dwellings) to the Building Regulations for the Republic of Ireland.

Typical constructions and U-values

Basement floors

Basement insulated with Kingspan GreenGuard® GG300

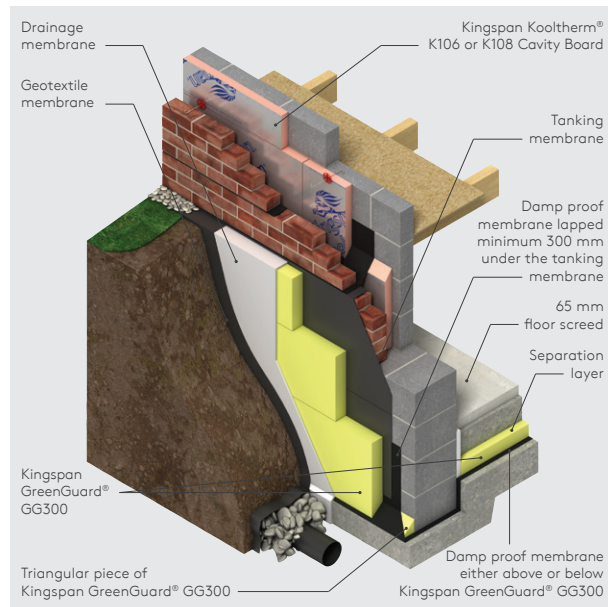


Figure 1

U-values (W/m ² K) for various thicknesses of Kingspan GreenGuard® GG300* and floor perimeter / area ratios						
Insulant thickness (mm)	Perimeter / area (m ⁻¹)					
	0.3	0.4	0.5	0.6	0.7	0.8
40	0.22	0.25	0.26	0.28	0.29	0.30
50	0.21	0.23	0.24	0.25	0.26	0.27
60	0.20	0.21	0.23	0.24	0.24	0.25
80	0.17	0.19	0.20	0.21	0.21	0.22
90 (40 + 50)	0.16	0.18	0.19	0.19	0.20	0.20
100	0.15	0.17	0.18	0.18	0.19	0.19
110 (50 + 60)	0.15	0.16	0.17	0.17	0.18	0.18
120	0.14	0.15	0.16	0.17	0.17	0.17
130 (80 + 50)	0.14	0.15	0.15	0.16	0.16	0.16
140 (80 + 60)	0.13	0.14	0.15	0.15	0.15	0.16
150	0.13	0.13	0.14	0.14	0.15	0.15
160 (80 + 80)	0.12	0.13	0.13	0.14	0.14	0.14
170 (120 + 50)	0.12	0.12	0.13	0.13	0.13	0.14
180	0.11	0.12	0.12	0.13	0.13	0.13
190 (150 + 40)	0.11	0.12	0.12	0.12	0.12	0.13
200 (100 + 100)	0.11	0.11	0.12	0.12	0.12	0.12
210 (150 + 60)	0.10	0.11	0.11	0.11	0.12	0.12
220 (120 + 100)	0.10	0.10	0.11	0.11	0.11	0.11
230 (150 + 80)	0.10	0.10	0.10	0.11	0.11	0.11
240 (120 + 120)	0.09	0.10	0.10	0.10	0.10	0.11
250 (150 + 100)	0.09	0.10	0.10	0.10	0.10	0.10
260 (100 + 100 + 60)	0.09	0.09	0.10	0.10	0.10	0.10
270 (150 + 120)	0.09	0.09	0.09	0.09	0.10	0.10
280 (180 + 100)	0.08	0.09	0.09	0.09	0.09	0.09
300 (150 + 150)	0.08	0.08	0.09	0.09	0.09	0.09
320 (100 + 100 + 120)	0.08	0.08	0.08	0.08	0.08	0.08
340 (100 + 120 + 120)	0.07	0.08	0.08	0.08	0.08	0.08
360 (180 + 180)	0.07	0.07	0.07	0.08	0.08	0.08

* The above table contains figures for Kingspan GreenGuard® GG300 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) for calculations for other products in the range.

NB Where multiple layers of insulation of different thicknesses are used, the thickest layer should be installed as the outermost layer in the construction.

NB If the insulation is installed below the damp proof membrane then design thermal conductivity values should be used for the purposes of U-value calculations.

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

Basement walls

Calculations for basement walls are based on the height of the basement, the P/A ratio of the basement floor and the thermal performance of the basement floor. Once all three variables have been obtained, please contact the Kingspan Insulation Technical Service Department (see rear cover) for the U-values to be calculated.

Design considerations

Heat loss and linear thermal bridging

Basic principles

Linear thermal bridging describes the heat loss or gain that occurs at junctions between elements e.g. where a basement wall meets the floor, or at junctions around openings in the building fabric where the thermal insulation layer is discontinuous e.g. sills, jambs and lintels.

Interruptions within the insulation layer by materials with poorer insulating properties can result in a thermal bridge, which in turn can lead to problems of condensation and mould growth, especially if there is a drop in surface temperature.

The heat flow at these junctions and opening locations, over and above that through the adjoining plane elements, is the linear thermal transmittance of the thermal bridge: measured in W/mK; referred to as a 'psi-value'; and expressed as a 'ψ-value'.

The lower the ψ-value, the better the performance. ψ-values are taken into account in the calculation methodologies e.g. the Standard Assessment Procedure (SAP) that are used to assess the operational CO₂ emissions and, where applicable, the fabric energy efficiency of buildings.

ψ-values can comprise either, or a combination of, approved, calculated or assumed values.

Approved details, such as the Acceptable Construction Details (Republic of Ireland) can uplift performance to provide a clear starting point towards achieving compliance, but can be limited in scope and applicability. The greatest opportunity for mitigating the impact of linear thermal bridges can come from following accurately 'modelled' details that take into account the following design considerations.

Reducing linear thermal bridging

Detailing at junctions to minimise the effects of thermal bridging and the associated risk of condensation or mould growth is important and there are some simple design considerations that can be adopted to help mitigate the risks and to reduce heat losses.

- Care is required to ensure continuation of insulation wherever possible between the basement wall and floor and also at the junction between the external wall, ground floor and basement wall for best thermal performance. Where this is not possible, the insulation should be overlapped and ideally, insulation material introduced between.
 - The best approach to minimise cold bridging is to take insulation externally of the construction and junction and to overlap this such that the wall insulation extends past the level of the floor insulation.
 - In order to minimise cold bridging at the edge of the floor, the distance between the top surface of the floor insulation or perimeter insulation upstand, and the bottom of the wall insulation must be a minimum of 150 / 225* mm. The further down the wall insulation extends past the floor insulation, the better the thermal performance of the junction between the wall and the floor.
- * 150 mm applies to the UK and 225 mm to the Republic of Ireland.
- Perimeter upstand insulation can also help to reduce heat losses from the junction between the floor and walls. The upstand insulation further increases the distance that the heat has to travel in order to escape through the junction, which therefore helps to reduce heat loss. Omitting this, or using a poorer performing insulation, can increase these losses.
 - Using better thermally performing blockwork for the basement and above ground wall constructions, particularly in adjacency to the junction with the floor, can assist with reducing heat losses from the junctions.
 - An internal lining of insulation on the warm side of the construction can also help to reduce heat losses through the junction. The internal lining, such as Kingspan Kooltherm® K118 Insulated Plasterboard (or Kooltherm® K18 in NI or ROI), could be used over the whole wall area, or a thin insulation layer could be used behind the wall lining adjacent to the junction to help reduce losses. A combination of external and internal insulation layers can be particularly effective to reduce cold bridging.

For further advice on details to reduce linear thermal bridging please contact the Kingspan Insulation Technical Service Department (see rear cover for details).

Design considerations

Responsible sourcing

Kingspan GreenGuard® GG300 and GG500 produced at Kingspan Insulation's Selby (North Yorkshire) manufacturing facility is certified to BES 6001 (Framework Standard for the Responsible Sourcing of Construction Products) 'Good'.



To download the certification please visit our [website](#).

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 at its Pembridge (Herefordshire) and Selby (North Yorkshire) manufacturing facilities is available upon request from literature@kingspaninsulation.co.uk.

Specification clause

Kingspan GreenGuard® should be described in specification as:-

The basement wall / floor insulation shall be Kingspan GreenGuard® GG300 / GG500 (delete as appropriate) _____ mm thick: comprising rigid extruded polystyrene insulation. The product shall be manufactured under a management system certified to ISO 9001: 2015, ISO 14001: 2015, ISO 45001: 2018, ISO 50001: 2018 and ISO 37301: 2021, and shall be installed in accordance with the instructions issued by Kingspan Insulation Limited.

Product classifications

Uniclass UK

Pr_25_71_63_29 Extruded polystyrene (XPS) boards

CAWS

GG300 and GG500

E20/200, K11/115, K11/125, K11/135, K11/145, K11/20, K11/215, K11/225, K11/235, K11/25, K11/295, M10/290, M10/40, M13/260, M13/40

GG500

J42/12

Details also available at the [NBS Source](#).

Building Information Modelling (BIM)

BIM objects for Kingspan GreenGuard® GG300 and GG500 can be downloaded using the Kingspan BIM Designer Software Tool available at: www.kingspaninsulation.co.uk.

Product selection

The high compressive strength of Kingspan GreenGuard® makes it particularly suitable for use where floor loads are to be severe.

Consideration must be given to which Kingspan GreenGuard® product is most appropriate for the required application. A table of the key distinguishing features is shown below.

Product	Thermal conductivity (W/mK)	Compressive strength (kPa)
Kingspan GreenGuard® GG300	0.033 W/mK (30 - 180 mm)	300
Kingspan GreenGuard® GG500	0.034 W/mK (50 mm) 0.036 W/mK (80 and 100 mm)	500

Design standards

Consideration should be given to the recommendations of BS 8102: 2022 (Code of practice for protection of structures against water from the ground), BS 8215: 1991 (Code of practice for design and installation of damp proof courses in masonry construction) and the information given in Building Research Establishment Digest 104 (Floor Screeds).

Waterproofing

BS 8102: 2022 provides guidance on protection of basements against ground water. The level of protection needed by a new basement in housing, offices, restaurants, leisure centres etc. is Grade 3 (refer to BS 8102 for a full list). Grade 3 protection consists of one of the following waterproofing options.

Tanking system - A continuous waterproofing membrane surrounding the exterior of the basement structure, preventing ground water from penetrating the basement construction. Available in mastic asphalt tanking, cementitious renders, self-adhesive membranes and liquid applied membranes (see Figure 1).

Waterproofed concrete - A continuous waterproofed concrete, mixed in accordance with BS EN 1992-3: 2006 (UK National Annex to Eurocode 2. Design of concrete structures. Liquid retaining and containment structures). The waterproofed concrete is used as the exterior of the construction to prevent water penetration.

Drained cavity & DPM - An effective drainage system where moisture that seeps through a monolithic wall, into the cavity is collected and channelled away under the floor. Using a DPM in conjunction with the drained cavity prevents any water penetrating the structure.

Sitework

General

- Kingspan Insulation recommends that suitable professional advice is sought when designing basements.

Drainage

- Water collecting at the base of Kingspan GreenGuard® must be drained away by filter drains located around the perimeter of the basement.
- To construct a filter drain, a perforated / porous drainage pipe should be positioned 200 mm below the floor level of the basement and should be surrounded by a free draining aggregate e.g. course gravel.
- A geotextile membrane must be placed around the gravel to prevent fines blocking the drain.
- Depending upon ground conditions, drains may be connected to surface drainage systems or soakaways.

Basement floors

Installation below a floor slab

- The site should be prepared and foundations, where appropriate, built to damp proof course (DPC) level.
- A thin sand blinding may be used to achieve a continuous level surface free from projections over rolled hardcore.
- The damp proof membrane (minimum 300 micron / 1200 gauge polythene) can be laid with joints well lapped and folded, to prevent the passage of ground water, either directly over the well compacted hardcore prior to laying the insulation boards, or over the insulation boards.
- The membrane should be laid under the basement wall, and under the triangular shaped piece of insulation placed between the concrete slab and the exterior of the basement wall, and lapped by 300 mm under the basement wall tanking membrane.
- Insulation boards should always be loose-laid break-bonded, with the joints lightly butted.
- If two layers of insulation are required, they should be horizontally offset relative to each other so that, as far as possible, the board joints in the two adjacent layers do not coincide with each other (see Figure 2).

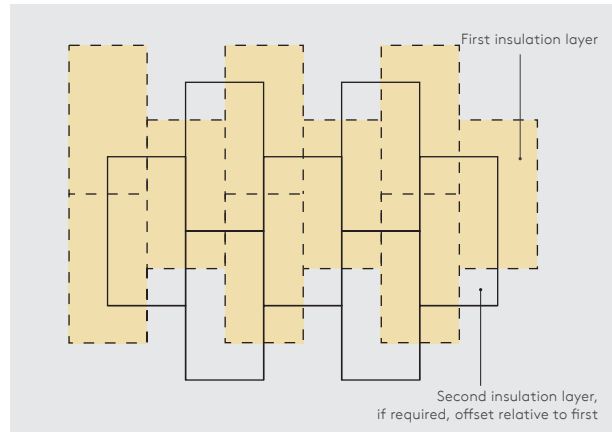


Figure 2 - Offsetting of multiple insulation layers

- A strip of rigid insulation board (minimum 20 mm thick) should be placed vertically around the perimeter of the floor slab in order to prevent cold bridging. The top of the strip of insulation board should be level with the top of the floor screed and the bottom should be level with the bottom of the horizontal floor insulation, and closely butted up to it.
- If the damp proof membrane is laid directly onto the hardcore below the insulation boards, the boards should be overlaid with a polythene sheet (not less than 125 micron / 500 gauge), to prevent the wet concrete penetrating the joints between the boards, and to act as a vapour control layer. Ensure the polythene sheet has 150 mm overlaps and is taped at the joints.
- The subsequent installation of the concrete slab and screed or other flooring material is carried out in a manner similar to that for an un-insulated floor.
- The concrete slab and screed should be allowed to dry out prior to the installation of the floor finish.

Installation below a floor screed

- Concrete slabs should be allowed to dry out fully prior to the installation of the insulation boards (average 1 day per mm of slab thickness).
- The surface of the slab should be smooth, flat and free from projections. Rough cast slabs should be levelled using a thin sand blinding to ensure boards are continuously supported.
- The damp proof membrane (minimum 300 micron / 1200 gauge polythene) should be laid with joints well lapped and folded, to prevent the passage of ground water, either directly over the floor slab prior to laying the insulation boards, or over the insulation boards.
- The membrane should be laid under the basement wall, and over the triangular shaped piece of insulation placed between the concrete slab and the exterior of the basement wall, and lapped by 300 mm under the basement wall tanking membrane.

Sitework

- Insulation boards should always be loose-laid break-bonded, with the joints lightly butted.
- If two layers of insulation are required, they should be horizontally offset relative to each other so that, as far as possible, the board joints in the two adjacent layers do not coincide with each other (see Figure 2).
- A strip of rigid insulation board (minimum 20 mm thick) should be placed vertically around the perimeter of the floor slab in order to prevent cold bridging. The top of the strip of insulation board should be level with the top of the floor screed and the bottom should be level with the bottom of the horizontal floor insulation, and closely butted up to it.
- Insulation boards should be overlaid with a polythene sheet (not less than 125 micron / 500 gauge), to prevent the wet screed penetrating the joints between the boards, and to act as a vapour control layer. Ensure the polythene sheet has 150 mm overlaps and is taped at the joints.
- Use sand and cement screed laid to a minimum thickness of 65 mm for domestic construction and 75 mm elsewhere.

Basement walls

- A triangular shaped piece of Kingspan GreenGuard® should be placed between the concrete slab and the exterior of the basement wall to create a slope (see Figure 1) and a platform for the basement wall insulation.
- The damp proof membrane should be laid under the basement wall and the triangular shaped piece of insulation, and connect with the basement wall tanking membrane in accordance with the tanking membrane manufacturer's recommendations.
- A tanking membrane is applied to the external face of the basement wall, to prevent water entering the basement structure.
- The insulation board should be installed outside of the tanking membrane.
- A cavity drainage membrane or layer of washed no fines gravel should be installed outside of the insulation boards.
- This relieves hydrostatic pressure and channels water to the foundation drain.
- The membrane or gravel should be covered with a geotextile layer to prevent fines from blocking the drainage material.
- The ground around the structure must slope away from the basement wall to ensure rainwater drains away from the building.

Waterstops

- When using reinforced concrete as the main structure of the basement, waterstops must be installed at the junctions where day joints have been made in the structure to prevent water leakage.

Refer to:

Movement Joints (UK) Ltd	+44 (0) 1354 60 79 60
Fosroc Ltd www.fosroc.com	+44 (0) 1827 262 222 +353 (01) 913 1024
Beton Construction Services Ltd www.beton.ie	+353 1 401 6402 +353 23 88 542 31

Wheeled / foot traffic

- Ensure boards are protected during installation from wheeled / foot traffic by using scaffold planks or other protective measures.

General

Cutting

- Cutting should be carried out either by using a fine toothed saw, a hot wire system 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 GreenGuard® is available through specialist insulation distributors and selected builders' merchants throughout the UK and Ireland.

Packaging and storage

- Kingspan GreenGuard® may be delivered in packaging bearing alternative product branding.
- 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 GreenGuard® 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 board dimensions or cause warping.

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 or 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 GreenGuard® GG300 and GG500 are rigid extruded polystyrene insulants with a fibre-free core. They are manufactured with a smooth, dense skin on both faces.



Standards and approvals

Kingspan GreenGuard® GG300 and GG500 are manufactured in accordance with the requirements of BS EN 13164: 2012 + A1: 2015 (Thermal insulation products for buildings. Factory made extruded polystyrene from (XPS) products. Specification).

Kingspan GreenGuard® GG300 and GG500 produced at Kingspan Insulation's Selby (North Yorkshire) manufacturing facility is manufactured under a management system certified to ISO 9001: 2015 (Quality management systems), ISO 14001: 2015 (Environmental Management Systems), ISO 45001: 2018 (Occupational Health and Safety Management Systems), ISO 50001: 2018 (Energy management systems) and ISO 37301: 2021 (Compliance management systems).

The use of Kingspan GreenGuard® GG300 in basements (in thicknesses of 30, 40, 50, 60, 70, 80, 100, 120, 140, 150 and 180 mm) is covered by BBA Certificate 22/6048.



NB The above information is correct at the time of writing. Please confirm at the point of need by contacting Kingspan Insulation's Technical Service Department (see rear cover), from which copies of Kingspan Insulation's certificates can be obtained.

Standard dimensions

All products in the Kingspan GreenGuard® range are available in the following standard size:

Nominal dimension	Availability
Length (mm)	1250 (and 2500 for GG300)
Width (mm)	600
Insulant thickness (mm)	Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.
Edge profile	Rebated (straight edge also available for GG300)

Compressive strength

The declared compressive strength of Kingspan GreenGuard® is as follows:

Kingspan GreenGuard® GG300 – 300 kPa; and
Kingspan GreenGuard® GG500 – 500 kPa,

when tested to BS EN 826 (Thermal insulating products for building applications. Determination of compression behaviour).

Water vapour resistivity

The products typically achieve a resistivity greater than 400 MNs/gm, when tested in accordance with BS EN 12086: 2013 (Thermal insulating products for building applications. Determination of water vapour transmission properties).

Absorption of moisture

Kingspan GreenGuard® is highly resistant to water absorption and the effects of freeze-thaw cycling.

Durability

If correctly installed, Kingspan GreenGuard® can have an indefinite life. Its durability depends on the supporting structure and the conditions of its use.

Resistance to solvents, fungi & rodents

Kingspan GreenGuard® 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 GreenGuard®, resulting in softening, shrinkage and possible dissolution, with a consequent loss of performance.

Kingspan GreenGuard® does not provide any food value to vermin and is not normally attractive to them.

Fire performance

Under System 4 AVCP, Kingspan GreenGuard® G300 and GG500 have a Euroclass rating of F.

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 GreenGuard® should not be brought into direct contact with high temperature heat sources. The maximum service temperature of Kingspan GreenGuard® is 75°C.

Product details

Thermal properties

The λ -values and R-values detailed below are quoted in accordance with BS EN 13164: 2012: + A1: 2015 (Thermal insulation products for buildings. Factory made extruded polystyrene foam (XPS) products. Specification).

Thermal conductivity

The boards achieve a thermal conductivity (λ -value) as follows:

Kingspan GreenGuard® GG300 is:

0.033 W/mK (insulant thickness 30 - 180 mm).

Kingspan GreenGuard® GG500 is:

0.034 W/mK (insulant thickness 50 mm); and

0.036 W/mK (insulant thickness 80 and 100 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 (m²K/W).

Insulant thickness (mm)	Thermal resistance (m ² K/W)	
	GG300	GG500
30	0.90	-
40	1.20	-
50	1.50	1.45
60	1.80	1.75
75	2.25	-
80	2.40	2.20
100	3.00	2.75
120	3.60	-
150	4.50	-
180	5.45	-

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 (manufactured thicknesses may vary between GB and IE).

NB Where a hyphen is shown the thickness is not available.

Contact details

Great Britain

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Pembroke | Leominster
Herefordshire | HR6 9LA

T: +44 (0) 1544 388 601

E: info@kingspaninsulation.co.uk

www.kingspaninsulation.co.uk

For individual department contact details please visit
www.kingspaninsulation.co.uk/contact

Ireland

Kingspan Insulation Ltd
Castleblayney | County Monaghan

T: +353 (0) 42 979 5000

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www.kingspaninsulation.ie

For individual department contact details please visit
www.kingspaninsulation.ie/contact



For the most up-to-date
version of this brochure
please scan or click [here](#).

To access pre-existing product information or information relating to previously sold/discontinued products please email literature@kingspaninsulation.co.uk.

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Kingspan Insulation Ltd is not associated with, and its products have not necessarily been tested by, the GREENGUARD Environmental Institute.

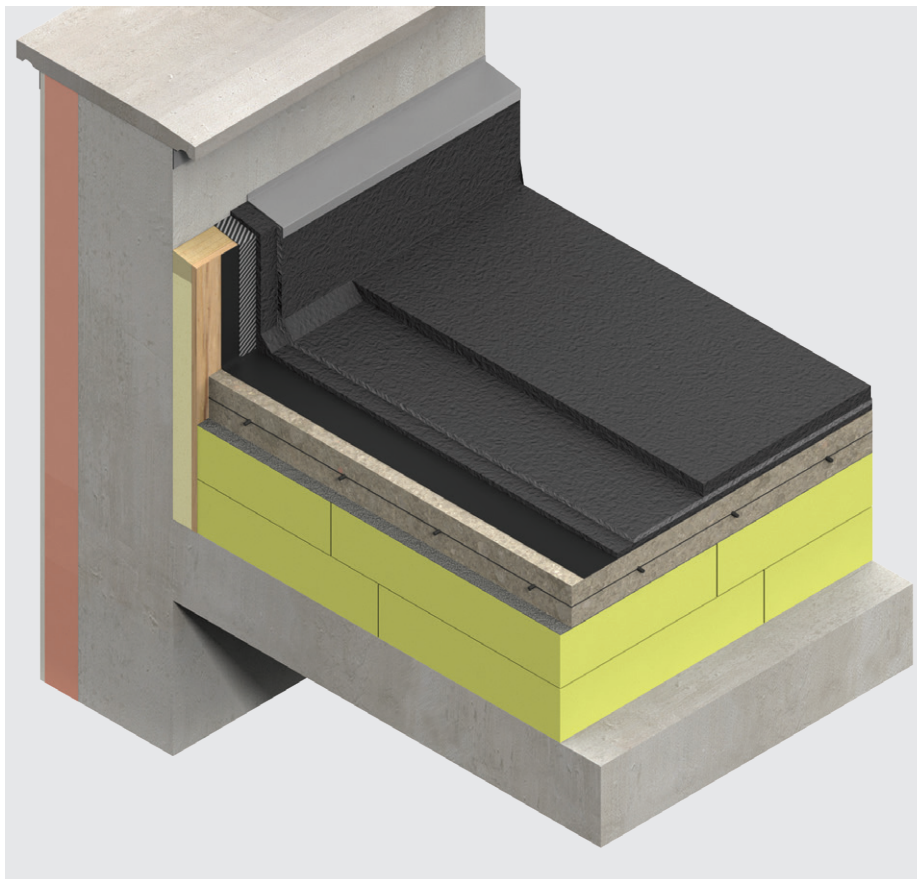
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Kingspan **GreenGuard**[®] Car Park Decks

Insulation for car park decks



- Rigid extruded polystyrene insulation - thermal conductivities as low as 0.033 W/mK
- High compressive strength withstands vehicle loads
- Resistant to the passage of water vapour
- Easy to handle and install compared to some other commonly used insulants
- Ideal for new build and refurbishment

Typical constructions and U-values

Assumptions

The U-values in the tables that follow have been calculated using the method detailed in BS EN ISO 6946: 2017 (Building components and building elements. Thermal resistance and thermal transmittance. Calculation methods), and using the conventions set out in BR 443 (Conventions for U-value calculations). They U-values in the tables that follow are valid for the constructions shown in the details immediately above each table.

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 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).

NB For guidance regarding the routes to compliance for meeting the fire safety requirements of the Building Regulations / Standards, refer to the relevant Technical Bulletins and links to Government websites at www.kingspaninsulation.co.uk/fireregulations (for GB) or contact technical services at technical@kingspaninsulation.ie (for Ireland).

U-value table key

Further information on the applicable notional and area weighted average U-values is available in the relevant geographical documentation:

- Approved Documents L to the Building Regulations for England;
- Approved Documents L to the Building Regulations for Wales;
- Technical Handbooks Section 6 to the Building Standards for Scotland;
- Technical Booklets F1 & F2 to the Building Regulations for Northern Ireland; and
- Technical Guidance Document L (Dwellings) and Technical Guidance Document L (Buildings other than Dwellings) to the Building Regulations for the Republic of Ireland.

Parking decks, cars and light commercial vehicles (non HGV)

(Maximum individual wheel load - 1 tonne)

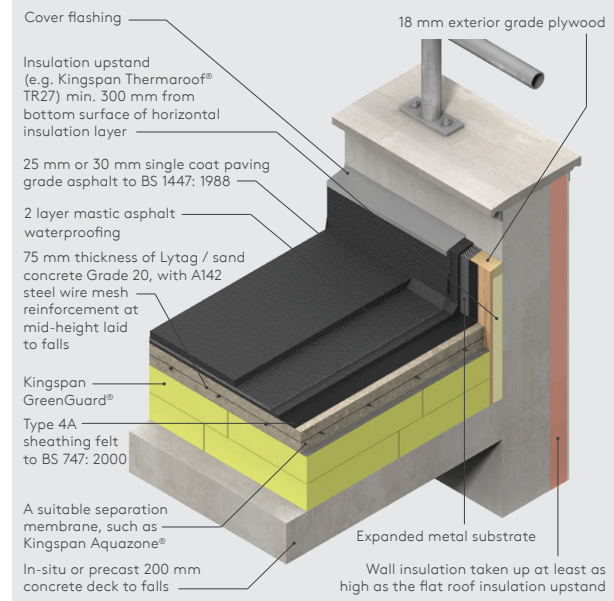


Figure 1

U-values (W/m ² K)	
Insulant thickness (mm)	Kingspan GreenGuard® GG300*
120	0.25
130 (80 + 50)	0.23
140 (80 + 60)	0.22
150	0.20
160 (80 + 80)	0.19
170 (120 + 50)	0.18
180	0.17
190 (150 + 40)	0.16
200 (100 + 100)	0.15
210 (150 + 60)	0.15
220 (120 + 100)	0.14
230 (150 + 80)	0.14
240 (120 + 120)	0.13
250 (150 + 100)	0.13
260 (100 + 80 + 80)	0.12
270 (150 + 120)	0.12
280 (100 + 180)	0.11
300 (150 + 150)	0.11
320 (100 + 100 + 120)	0.10
340 (100 + 120 + 120)	0.09
360 (180 + 180)	0.09
380 (100 + 100 + 180)	0.08

* The above table contains figures for Kingspan GreenGuard® GG300 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) or U-value Calculator for calculations for other products in the range.

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

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

Typical constructions and U-values

Loading bays, service decks and commercial vehicles

(Design should be verified as to suitability for specific wheel loads)

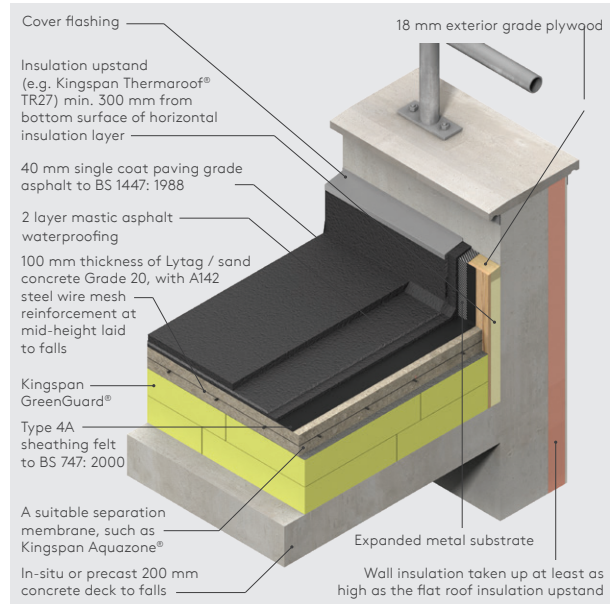


Figure 2

U-values (W/m ² K)	
Insulant thickness (mm)	Kingspan GreenGuard® GG700*
120 (60 + 60)	-
140 (80 + 60)	0.23
160 (80 + 80)	0.21
180 (50 + 50 + 80)	0.18
200 (100 + 100)	0.17
220 (80 + 80 + 60)	0.15
240 (80 + 80 + 80)	0.14

* The above table contains figures for Kingspan GreenGuard® GG700 only. Please consult the Kingspan Insulation Technical Service Department (see rear cover) or U-value Calculator for calculations for other products in the range.

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

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

U-values (W/m ² K)	
Insulant thickness (mm)	Kingspan GreenGuard® GG500*
130 (80 + 50)	0.25
150 (100 + 50)	0.21
160 (80 + 80)	0.20
180 (100 + 80)	0.18
200 (100 + 100)	0.17
210 (80 + 80 + 50)	0.16
240 (80 + 80 + 80)	0.14
260 (100 + 80 + 80)	0.13
280 (100 + 100 + 80)	0.12
300 (100 + 100 + 100)	0.11

* The above table contains figures for Kingspan GreenGuard® GG500 only. Please consult the Kingspan Insulation Technical Service Department or U-value Calculator (see rear cover) for calculations for other products in the range.

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

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

Design considerations

Linear thermal bridging

Basic principles

Linear thermal bridging describes the heat loss / gain that occurs at junctions between elements e.g. where an external wall meets the roof, or at junctions around openings in the building fabric where the thermal insulation layer is discontinuous e.g. sills, jambs and lintels.

Interruptions within the insulation layer by materials with poorer insulating properties can result in a thermal bridge, which in turn can lead to problems of condensation and mould growth, especially if there is a drop in surface temperature.

The heat flow at these junctions and opening locations, over and above that through the adjoining plane elements, is the linear thermal transmittance of the thermal bridge: measured in W/mK; referred to as a 'psi-value'; and expressed as a ' ψ -value'.

The lower the ψ -value, the better the performance. ψ -values are taken into account in the calculation methodologies e.g. the Standard Assessment Procedure (SAP) that are used to assess the operational CO₂ emissions and, where applicable, the fabric energy efficiency of buildings.

ψ -values can comprise either, or a combination of, approved, calculated or assumed values.

Reducing linear thermal bridging

Detailing at junctions to minimise the effects of thermal bridging and the associated risk of condensation or mould growth is important. There are some simple design considerations that can be adopted to help mitigate the risks and to reduce heat losses.

Care is required to ensure continuation of insulation wherever possible between the wall and roof for best thermal performance. Where this is not possible, the roof and wall insulation should be overlapped and ideally, insulation material introduced between.

Parapet detailing can represent a good, low heat loss approach, with insulation continuity maintained using an insulated upstand to reduce cold bridging. A Kingspan Thermarroof® TR27 upstand should be used around the perimeter of the roof on the internal façade of parapets to achieve a minimum thermal resistance of 1.10 m²K/W. The upstand should extend a minimum of 150 mm above the roof insulation and achieve a minimum distance of 300 mm between the top of the insulation upstand and the bottom of the horizontal roof insulation. Wall insulation should be carried up into parapets at least as high as the flat roof insulation upstand.

Where possible, insulate around internal rainwater downpipes and other pipes that penetrate the roof if they pass through spaces with a high humidity and if any condensate will damage the structure or internal finishes. Use Kingspan GreenGuard® around the pipe outlet and wrap joints with vapour resistant tape to restrict water vapour from reaching the pipe.

Where guttering is incorporated within a flat roof construction, this should be accounted for within the overall thermal design of the roof via an area-weighted calculation for the whole roof; the risk of localised interstitial condensation from reduced insulation provision at the gutter should be considered.

Where an Internal gutter is formed, where practicable, vertical insulation can be used to reduce thermal bridging.

Responsible sourcing

Kingspan GreenGuard® GG300 and GG500 produced at Kingspan Insulation's Selby (North Yorkshire) manufacturing facility is certified to BES 6001



(Framework Standard for the Responsible Sourcing of Construction Products) 'Good'.

To download the certification, please visit our [website](#).

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 at its Pembridge (Herefordshire) and Selby (North Yorkshire) manufacturing facilities is available upon request from literature@kingspaninsulation.co.uk.

Specification clause

Kingspan GreenGuard® should be described in the specification as:-

The roof insulation shall be Kingspan GreenGuard® GG300 / GG500 / GG700 (delete as appropriate) ____mm thick: comprising rigid extruded polystyrene insulation. The product shall be manufactured under a management system certified to ISO 9001: 2015, ISO 14001: 2015, ISO 45001: 2018 and ISO 50001: 2018, and shall be installed in accordance with the instructions issued by Kingspan Insulation Limited.

Product classifications

Uniclass UK

Pr_25_71_63_29 Extruded polystyrene (XPS) boards

CAWS

GG300, GG500 and GG700

E20/200, J42/10, M10/290, M10/40, M13/260, M13/40

GG500

J42/12

Details also available at the [NBS Source](#).

Design considerations

Building Information Modelling (BIM)

BIM objects for Kingspan GreenGuard® GG300 and GG500 can be downloaded using the Kingspan BIM Designer Software Tool available at www.kingspaninsulation.co.uk.

Product selection

The high compressive strength of Kingspan GreenGuard® makes it particularly suitable for use in car park applications where there are likely to be heavy loads.

Consideration must be given to which Kingspan GreenGuard® product is most appropriate for the required application. A table of the key distinguishing features is shown below.

Product	Thermal conductivity (W/mK)	Compressive strength (kPa)
Kingspan GreenGuard® GG300	0.033 W/mK (30 - 180 mm)	300
Kingspan GreenGuard® GG500	0.034 W/mK (50 mm) 0.036 W/mK (80 and 100 mm)	500
Kingspan GreenGuard® GG700	0.035 W/mK (50, 60 and 80 mm)	700

Design loads & roof structure

Whilst almost any form of roof deck (timber, metal or concrete) can be used with protected membrane roofing systems, the traffic load and additional dead load from the ballast layer invariably limits this type of roof to concrete decks.

Data on specific concentrated loads is contained in BS EN 1991-1-1: 2002 (Eurocode 1. Actions on structures. General actions. Densities, self-weight, imposed loads for buildings) and BS EN 1991-1-7:2006 + A1: 2014 (Eurocode 1. Actions on structures. General actions. Accidental actions). Department of Transport departmental standard BD 21/84 gives typical single wheel loads, depending on the type of vehicle, that act over a 150 mm square or 170 mm diameter contact area. The tyre pressure is taken as 1.1 N/mm², in practice real tyre pressures are lower than this thus giving a lower load intensity.

Vehicle type (weight in tonnes)	Nominal single wheel load (kN)
Cars and vans (< 3)	125
Vehicles generally (3 - 7.5)	50
Vehicles generally (7.5 - 40)	100
Fire engines (up to 60 kN axle load)	30
Fire engines (up to 120 kN axle load)	60

Falls

The fall on a car park deck, constructed using Kingspan GreenGuard®, is normally provided by the screed being laid to falls 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: 2018 (Flat roofs with continuously supported flexible waterproof 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.

Roof waterproofing

Kingspan GreenGuard® is suitable for use with 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 EN 13707: 2013 (Flexible sheets for waterproofing. Reinforced bitumen sheets for roof waterproofing. Definitions and characteristics), itself laid over a layer of Lytag / sand concrete, Grade 20, laid to falls with A142 steel wire mesh reinforcement at mid-height. The exposed face of insulation upstands, at parapets and abutments, must be lined with 18 mm exterior grade plywood, prior to the mastic asphalt waterproofing being laid. The plywood is used as an anchor point for the expanded metal substrate onto which the vertical mastic asphalt is laid.

Water vapour control

There is no requirement for a vapour control layer on car park decks where Kingspan GreenGuard® is overlaid with screed and a mastic asphalt finish. However, this type of roof build up can not be used on high humidity buildings.

Sitework

Insulation boards

- Concrete decks should be clean, dry, without large projections, steps or gaps.
- Start laying the Kingspan GreenGuard® 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 3).

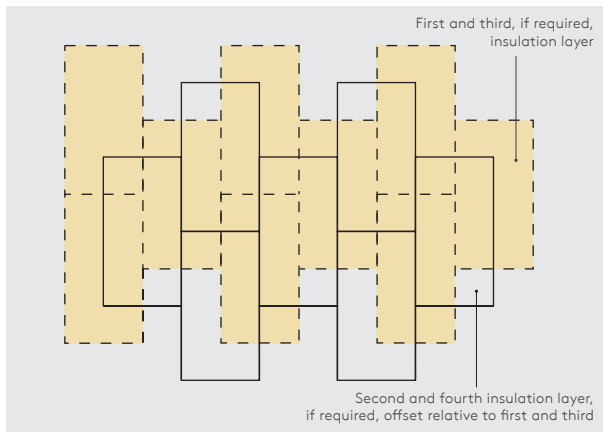


Figure 3 - Offsetting of multiple insulation layers

- Roof-light or ventilator kerbs etc. should always be insulated with Kingspan Thermarroof® TR27 to the same U-value as the general roof area.
- A Kingspan Thermarroof® TR27 upstand should be used around the perimeter of the roof on the internal façade of parapets to achieve a minimum thermal resistance of 1.10 m²K/W.
- 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.

Screed and mastic asphalt

- A suitable separation membrane, such as Kingspan Aquazone® should be laid over the boards and turned up at abutments.
- Reinforcement can then be fixed and the concrete poured and compacted in accordance with BS EN 1992-1-1: 2004 + A1: 2014 (Eurocode 2: Design of concrete structures. General rules and rules for buildings).
- The mastic asphalt waterproofing is installed in accordance with the membrane manufacturer's instructions, over the whole insulated area including any insulation upstands.

General

Cutting

- Cutting should be carried out either by using a fine toothed saw, a hot wire system 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 GreenGuard® is available through specialist insulation distributors and selected builders merchants throughout the UK and Ireland.

Packaging and storage

- Kingspan GreenGuard® may be delivered in packaging bearing alternative product branding.
- 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 GreenGuard® 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 or 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 GreenGuard® GG300, GG500 and GG700 are rigid extruded polystyrene insulants with fibre-free cores. They are manufactured with a smooth, dense skin on both faces.



Standards and approvals

Kingspan GreenGuard® GG300 and GG500 are manufactured in accordance with the requirements of BS EN 13164: 2012 + A1: 2015 (Thermal insulation products for buildings. Factory made extruded polystyrene from (XPS) products. Specification).

Kingspan GreenGuard® GG300 and GG500 produced at Kingspan Insulation's Selby (North Yorkshire) manufacturing facility is manufactured under a management system certified to ISO 9001: 2015 (Quality management systems), ISO 14001: 2015 (Environmental Management Systems), ISO 45001: 2018 (Occupational Health and Safety Management), ISO 50001: 2018 (Energy management systems) and ISO 37301: 2021 (Compliance management systems).

Standard dimensions

All products in the Kingspan GreenGuard® range are available in the following standard size:

Nominal dimension	Availability
Length (mm)	1250 (and 2500 for GG300)
Width (mm)	600
Insulant thickness (mm)	Refer to local distributor or Kingspan Insulation price list for current stock and non-stock sizes.
Edge profile	Rebated (straight edge also available for GG300)

Compressive strength

The declared compressive strength of Kingspan GreenGuard® is as follows:

Kingspan GreenGuard® GG300 - 300 kPa;
Kingspan GreenGuard® GG500 - 500 kPa; and
Kingspan GreenGuard® GG700 - 700 kPa,

when tested to BS EN 826 (Thermal insulating products for building applications. Determination of compression behaviour).

Water vapour resistivity

The products typically achieve a resistivity greater than 400 MN s/gm when tested in accordance with BS EN 12086: 2013 (Thermal insulating products for building applications. Determination of water vapour transmission properties).

Absorption of moisture

Kingspan GreenGuard® is highly resistant to water absorption and the effects of freeze-thaw cyclings.

Durability

If correctly installed, Kingspan GreenGuard® can have an indefinite life. Its durability depends on the supporting structure and the conditions of its use.

Resistance to solvents, fungi & rodents

Kingspan GreenGuard® 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 GreenGuard®, resulting in softening, shrinkage and possible dissolution, with a consequent loss of performance.

Kingspan GreenGuard® does not provide any food value to vermin and is not normally attractive to them.

Fire performance

Under System 4 AVCP, Kingspan GreenGuard® G300, GG500 and GG700 have a Euroclass rating of F.

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 GreenGuard® should not be brought into direct contact with high temperature heat sources. The maximum service temperature of Kingspan GreenGuard® is 75°C.

Product details

Thermal properties

The λ -values and R-values detailed below are quoted in accordance with BS EN 13164: 2012: + A1: 2015 (Thermal insulation products for buildings. Factory made extruded polystyrene foam (XPS) products. Specification).

Thermal conductivity

The boards achieve a thermal conductivity (λ -value) as follows:

Kingspan GreenGuard® GG300 is:

0.033 W/mK (insulant thickness 30 - 180 mm).

Kingspan GreenGuard® GG500 is:

0.034 W/mK (insulant thickness 50 mm); and

0.036 W/mK (insulant thickness 80 and 100 mm).

Kingspan GreenGuard® GG700 is:

0.035 W/mK (insulant thickness 50, 60 and 80 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 (m²K/W).

Insulant thickness (mm)	Thermal resistance (m ² K/W)		
	GG300	GG500	GG700
30	0.90	-	-
40	1.20	-	-
50	1.50	1.45	1.40
60	1.80	1.75	1.70
75	2.25	-	-
80	2.40	2.20	2.25
100	3.00	2.75	-
120	3.60	-	-
150	4.50	-	-
180	5.45	-	-

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 (manufactured thicknesses may vary between GB and IE).

NB Where a hyphen is shown the thickness is not available.

About Kingspan Insulation

Company details

Kingspan Insulation Ltd is part of the Kingspan Group plc., one of Europe's leading construction product manufacturers. The Kingspan Group was formed in the late 1960s and is a publicly quoted group of companies headquartered in Kingscourt, County Cavan, Ireland.

Kingspan Insulation Ltd is a market leading manufacturer of premium and high performance rigid insulation products and insulated systems for building fabric and building services applications.

Products & solutions

Optimum, premium and high performance rigid insulation products for building fabric applications, including roofs, walls and floors.

- Kingspan AlphaCore® - premium performance microporous silica-based insulation.
- Kingspan OPTIM-R® - optimum performance vacuum insulation panel (VIP) systems.
- Kingspan Kooltherm® - premium performance phenolic insulation.
- Kingspan Therma™ - high performance PIR insulation.
- K-Roc® - rock mineral fibre insulation.
- Kingspan GreenGuard® - extruded polystyrene insulation (XPS).
- Kingspan Aerobord® - EPS insulation.
- Kingspan TEK® - structural insulated panels (SIPs).
- Cavity closers - PVC-U extrusions with an insulation core.
- Membranes - for pitched roofs and walls.

Services

We are proud to offer one of the most advanced support services in the construction industry, designed to give fast and accurate advice no matter what your role is. Visit our website to access the following services.

- U-value calculations - free, quick and easy U-value calculations with our U-value Calculator.
- Help and advice on your projects, including stockists, how to guides, regulatory guidance and e-learning.
- Building Information Modelling (BIM) - download BIM objects for our products.
- Tapered roofing service - Kingspan Insulation's tapered roofing systems come with a supporting design service to ensure the most cost-effective solution for a roof is identified.
- CPDs - Kingspan Insulation offer a number of free CPD seminars for architects and specifiers covering a wide range of industry topics. CPDs can be booked or a range of online learning courses can be found online.

Planet Passionate

Planet Passionate is our ambitious Group-wide environmental sustainability programme. Click [here](#) for more information on our targets and progress to date.

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