Insulation

First Issue October 2015

Building Standards for Energy

SCOTLAND – DOMESTIC

2015 EDITION

Kingspan®

Low Energy –
Low Carbon Buildings

Contents

Introduction

Section 6 Technical Handbooks

Technical Handbooks, published by the Scottish Government's Building Standards Division (BSD), give technical guidance on how to meet the energy efficiency requirements of Section 6, as amended, for building work carried out in Scotland.

There are two Technical Handbooks for Section 6:

- Section 6 (energy) 2015 – Domestic
- Section 6 (energy) 2015 – Non–domestic

Each document sets out what, in ordinary circumstances, may be accepted as reasonable provision for compliance with the energy efficiency requirements of the Building Standards for the type of building work in question.

Developers can also refer to Section 7 (sustainability) which goes beyond the requirements of Section 6 (energy). Section 7 (sustainability) addresses the following:

- Climate change, energy and resource use.
- Quality of life, material use and waste.

For more information, please refer to the Scottish Government's Building Standards Division's website.

About this Document

Kingspan Insulation has produced this document as a simple guide to the 2015 edition of Section 6 (energy), including the salient changes from the 2011 edition. The guide is split into two parts: new dwellings and existing dwellings. It specifically concentrates on the parts that are relevant to the building fabric insulation, whilst showing how compliance can be achieved using Kingspan Insulation products for roofs, walls and floors and, for the purpose of comparison, thermally equivalent solutions using other common insulation materials.

Section 6 (Energy) – Domestic

Introduction

The 2015 edition of the Section 6 (energy) – Domestic standard (applicable for works from October 2015), gives guidance to ensure that effective measures for the conservation of fuel and power are incorporated into dwellings. This is done through requirements for a better performing building fabric and improved carbon dioxide emission targets.

Types of Work Covered

Section 6 (energy) – Domestic is applicable to the following domestic buildings:

- houses, flats and maisonettes;
- ancillary buildings that are to be heated (except for those buildings that are heated solely for the purpose of frost protection);
- stand–alone heated buildings; and
- existing buildings (where alterations, extensions or replacement work is carried out on an existing building).

Common areas or heated accommodation associated with a block of dwellings, that are less than 50 m^2, should be treated as a stand–alone building and should have U–values equal to or better than those for the rest of the building.

The regulation does make provision for where there may be constraints on existing buildings. In these situations, individual standards might not apply.

There is a separate Technical Handbook for non–domestic properties.

Compliance with Building Standards

Demonstrating Compliance

Section 6 (energy) – Domestic provides criteria that must be met in order to demonstrate compliance with the energy efficiency requirements of the Building Standards. These criteria comprise a mix of mandatory requirements and statutory guidance, some of which have little or no significance to insulation. Those that do are outlined below.

First and foremost, there is a need to show that the designed carbon dioxide (CO_2) emission rate for a dwelling (referred to as the 'Dwelling CO_2 Emission Rate' and expressed as 'DER'), does not exceed a defined maximum allowable emission rate (referred to as the 'Target CO_2 emission rate' and expressed as 'TER').

TER and DER calculations must be carried out by an accredited energy assessor in accordance with the National Calculation Methodology (NCM) i.e. the 2012 edition of the Standard Assessment Procedure (SAP 2012). A 'notional dwelling' concurrent specification, is used to determine the TER, with the notional dwelling specification differing by heating fuel type.

Secondly, individual building fabric elements and fixed building services must meet or exceed specified energy efficiency backstop standards.

Thirdly, there is a need to show that the quality of construction is such that the energy performance of the dwelling 'as built' matches or exceeds that 'as designed'.

Evidence of Compliance

Much of the evidence for demonstrating compliance can comprise the results of SAP calculations.

On submitting a building regulations application, a carbon compliance calculation, commonly referred to as a 'design stage SAP', is required. The edition and version of the assessment current when the application is made is then set for the duration of the project for compliance purposes. So if a dwelling was assessed at design stage under SAP 2012, then compliance at the as–built stage would be to the same edition and version.

At the post–construction ('as built') stage, the Energy Performance Certificate (EPC) should be produced by an accredited assessor, using approved software which implements the current edition and version of the calculation methodology (SAP). This ensures that building owners are presented with the most current and relevant information practicable.

Both the 'designed' and 'as built' submissions include the TER / DER calculation as well as a list of specifications, which demonstrate how compliance has been achieved.

NB The 'as built' submission used to produce the EPC must also include the assessed air–permeability of the dwelling and any changes to the 'designed' specification.

The two submissions can be compared and used by Building Control to assist in checking whether what has been built matches or betters what was designed.

CO_2 Emissions & Fabric Energy Efficiency

Section 6 (energy) – Domestic adopts a 'whole building' approach to minimising CO_2 emissions and fabric energy efficiency. A new dwelling must be designed and built such that its DER is no worse than its TER.

The TER and DER are expressed as the mass of CO_2 in kilograms per square metre of floor area per annum (kg/m²/yr). TER and DER calculations take account of the CO_2 emission rate from space heating, hot water, ventilation and internal fixed lighting requirements using standardised assumptions for household occupancy set by the NCM.

Also considered in the calculations is the thermal mass of the dwelling and minor heat gains from different sources, e.g. the sun, the occupants, household appliances and artificial lighting.

A 'notional dwelling' of the same size and shape as the 'actual dwelling', built to a concurrent specification, is used to determine the TER. The notional dwelling specification for each fuel type is summarised in Section 6.1 of the domestic Technical Handbook. The main elements of the concurrent specification of the notional dwelling that relate to the opaque building fabric are shown in Table 1. Whilst the concurrent specification helps to set the target, the actual specification will usually differ from this.

Following this specification is considered to satisfy the requirements of the building standards, but should not be used where there is any deviation from the packages which would result in higher CO_2 emissions. An Energy Performance Certificate (EPC) will still be required on completion of the dwelling, which necessitates SAP calculations to be undertaken in any respect.

This approach differs from that used for England and for Wales, in that there is no adjustment to target setting based on a fuel factor. Instead, the actual concurrent specification used for target setting differs depending on the main heating fuel type chosen.

It is important to note that there is no formal requirement for low carbon equipment, although the feasibility of their use must be assessed. If the developer chooses this route, the building specification would need to compensate for the lack of such equipment.

Element or System	Gas (Package 1)	LPG (Package 2)	Oil (Package 3)	Electricity (Package 4)	Biomass (Package 5)
All Roofs	0.11 W/m²·K	0.11 W/m²·K	0.11 W/m²·K	0.11 W/m²·K	0.11 W/m²·K
Walls	0.17 W/m²·K	0.17 W/m²·K	0.17 W/m²·K	0.17 W/m²·K	0.17 W/m²·K
Floors	0.15 W/m²·K	0.15 W/m²·K	0.15 W/m²·K	0.15 W/m²·K	0.15 W/m²·K
Openings	1.4 W/m²·K	1.4 W/m²·K	1.4 W/m²·K	1.4 W/m²·K	1.4 W/m²·K
Party Walls	0.0 W/m²·K	0.0 W/m²·K	0.0 W/m²·K	0.0 W/m²·K	0.0 W/m²·K
Allowance for Thermal Bridging	0.08 x total exposed surface area	0.08 x total exposed surface area	0.08 x total exposed surface area	0.08 x total exposed surface area	0.08 x total exposed surface area
Open Flues	None	One	One	None	One
Heating System, Pump in Heated Space	Gas boiler room – sealed fan flued 89% efficiency	LPG boiler room – sealed fan flued 89% efficiency	Oil boiler room – sealed fan flued 90% efficiency	Air to water heat pump 175.1% efficiency	Wood pellet boiler 86% efficiency, HETAS approved
Heating System Controls	Time and temperature zone control + boiler interlock + weather compensation + delayed start	Time and temperature zone control + boiler interlock + weather compensation + delayed start	Time and temperature zone control + boiler interlock + weather compensation + delayed start	Time and temperature zone control	Time and temperature zone control + delayed start
Hot Water (HW) System	Stored HW (from boiler), separate time control for space and water heating	Stored HW (from boiler), separate time control for space and water heating	Stored HW (from boiler), separate time control for space and water heating	Stored HW (electric immersion), separate time control for space and water heating	Stored HW (from boiler), separate time control for space and water heating
Secondary Space Heating	None	10% closed wood log–burning room heater	10% closed wood log–burning room heater	10% electric	none
Heat Recovery Systems	Instantaneous waste water heat recovery system, 45% efficiency	Instantaneous waste water heat recovery system, 45% efficiency	Instantaneous waste water heat recovery system, 45% efficiency	Instantaneous waste water heat recovery system, 45% efficiency	Instantaneous waste water heat recovery system, 45% efficiency
Photovoltaics	Yes	Yes	Yes	No	No
Air–tightness	7 m³/hr/m² at 50 Pa				
Linear Thermal Transmittance	0.08 x total exposed surface area				
Thermal Mass	The value identified for the proposed building should be used				
Lighting	Low energy lighting				

Table 1: Selected Reference Values from the Section 6 (Energy) – Domestic Notional Dwelling Specification

Limits on Design Flexibility

Limiting Fabric Standards

Scottish Building Standards Section 6 sets out area weighted limiting U–value standards for the different fabric elements of the dwelling. This provision, which is mandatory, is included to make the design of the dwelling robust should the performance of one fabric element fail or perform less well than expected.

The limiting U–values for the different element types are shown in Table 2. It is of note that the use of the limiting U–values will almost certainly result in the dwelling failing to achieve the required TER, thus U–values, significantly better than those shown, are likely to be required.

NB The values shown in Table 2 are **not** the U–values that should be adopted for compliance with the Building Standards. For guidance, see the 'Simplifying the Complex' section of this document.

Fabric Element	Area Weighted average U–value ($W/m^2 \cdot K$) for all elements of the same type	Individual element ($W/m^2 \cdot K$)
Roofs	0.15	0.35
Walls	0.22	0.70
Floors	0.18	0.70
Party Walls	0.20	
Windows, Roof Windows, Rooflights & Doors	1.60	3.30

Table 2: Limiting Fabric Parameters

Limits for Air–permeability & Building Services

There is no firm limiting value set for air–permeability, however a recommended limiting value of 10 $m^3/hr/m^2$ at 50 Pa is given. In addition, limits are also given for the energy performance of the fixed building services in the dwelling, the minimum energy efficiency standards for which are set out in the Domestic Building Services Compliance Guide.

If satisfactory performance is not achieved, then remedial measures should be carried out on the dwelling and additional tests carried out until the criteria set out above are achieved. Additional testing may also be required of other dwellings.

Linear Thermal Bridging

The building fabric should be constructed so that there are no reasonably avoidable thermal bridges: in the insulation layers caused by gaps within the various elements; at the joints between elements; and at the edges of elements such as those around windows and door openings.

Reasonable provision would be:

a. input of default ψ–values for each junction listed within Appendix K of SAP 2012;
b. where construction of a junction follows the 'Accredited Construction Details (Scotland) 2015' or other published and substantiated construction detail sets, input of ψ–values of the relevant junction(s) from that document;
c. input of ψ–values calculated by a person with suitable expertise and experience following the guidance set out in BR 497; or
d. use a combination of a, b and c.

Whilst the change is yet to be reflected in Section 6 (energy) – Domestic, it has been announced that default 'y–values' of 0.15 can no longer be used in calculations submitted to support building warrants. Energy assessors will instead be required to calculate the Htb from the sum of junctions and ψ–values.

Air-Permeability Testing

For each separate development, air–pressure testing will typically be required, although a developer can choose to avoid the need to pressure test by using an air–permeability value of 15 $m^3/hr/m^2$ at 50 Pa when calculating the DER (this however makes it significantly more difficult for a dwelling to comply).

Simplifying the Complex

The Section 6 (energy) – Domestic notional dwelling specification provides a useful function in that it provides a straightforward elemental route to compliance. If the actual dwelling is built entirely to the notional dwelling specification, it will meet the CO_2 emissions and fabric energy efficiency targets, as well as the limiting values for individual fabric elements and fixed building services. This is known as the simplified approach.

Nonetheless, there is still huge scope for flexibility, should developers want it. Developers can, if they prefer, choose to diverge from the notional dwelling specification, so long as the dwelling 'as built' achieves, or exceeds the TER, as well as the limiting values.

Developers could choose to omit the renewables required as part of the concurrent specification and instead concentrate on an improved fabric and good thermal bridging details, combined with a high level of air permeability and a mechanical ventilation system with heat recovery. This would reduce the requirement for often costly, and sometimes short–lived, renewables. It would future–proof the building fabric, whilst still allowing for the possibility to add on renewables should they be needed to meet future regulations.

Modelling carried out by Kingspan Insulation suggests that the values shown in Table 3 are the best starting point U–values if adopting this approach.

Element	U–value ($W/m^2 \cdot K$)
All Roofs	0.10
Walls	0.15
Floors	0.13

Table 3: Best Starting Point U–values

Constructions & U-values

Set out in the following pages are examples of constructions using Kingspan Insulation products, which are designed to achieve:

- the U–values given in the Section 6 (energy) – Domestic notional dwelling specification, see Table 1; or
- the best starting point U–values, see Table 3, should the specification diverge from that given in the Section 6 (energy) – Domestic notional dwelling specification.

Each example construction is accompanied by a table, which gives the corresponding U–values and shows the practical thicknesses of Kingspan Insulation products required to achieve them. It is important to note that these U–values are valid only for the illustrated construction. Furthermore, these constructions do not comprise an exhaustive list of Kingspan Insulation solutions. Contact the Kingspan Insulation Technical Service Department if calculations for other constructions are required.

In addition, possible alternative solutions using other common insulation materials are shown for the purpose of comparison.

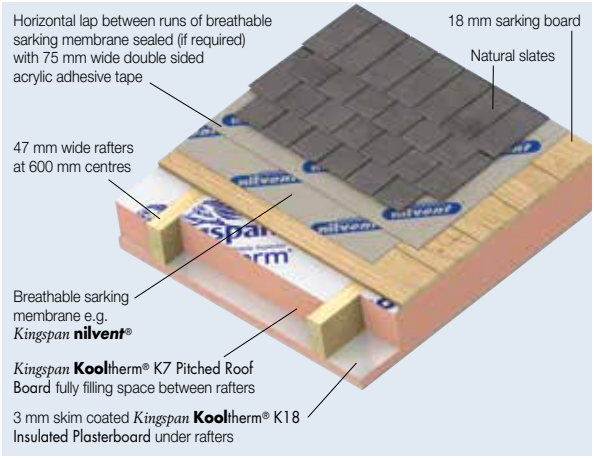
U–values have been calculated using the methods detailed in:

- BS EN ISO 6946: 2007 (Building components & building elements. Thermal resistance and thermal transmittance. Calculation method);
- BS EN ISO 13370: 1998 (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).

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

All figures quoted are for guidance only. A detailed U–value calculation and a condensation risk analysis should be carried out for each project. In which case, contact the Kingspan Insulation Technical Service Department for assistance.

Pitched Roof – Insulation Between & Under Rafters



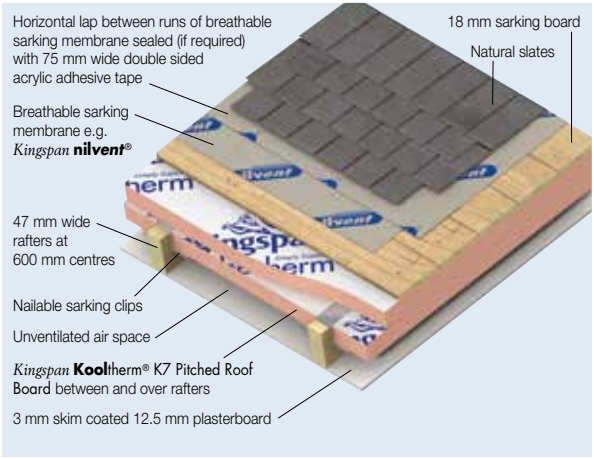
Insulation Thicknesses to Achieve Different U–values

	U–value (W/m²·K)								
	0.11				0.10				
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Under Rafter Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Under Rafter Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	
Kingspan Kooltherm®	150	150	67.5	217.5	150	150	82.5	232.5	THINNER
	175	175	52.5	227.5	175	175	72.5	247.5	
Glass Fibre* (Between) & XPS** (Under)	200	200	147.5	347.5	200	200	177.5	377.5	THICKER

**Assuming thermal conductivity 0.037 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K.*
****All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. The effect of fixings for the insulated plasterboard assumed in the calculations above is insignificant, since the insulation layer penetrated is not the main insulation layer.

Using *Kingspan* **Kool**therm® can result in a much thinner overall construction, regardless of rafter depth, and is less likely to have a prohibitive effect on headroom. There may be severe practicality issues with fixing a 147.5 or 177.5 mm insulated plasterboard product.

Pitched Roof – Insulation Between & Over Rafters



Insulation Thicknesses to Achieve Different U–values

	U–value (W/m²·K)							
	0.11				0.10			
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Over Rafter Insulation Thickness (mm)	Overall Thickness (mm)	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Over Rafter Insulation Thickness (mm)	Overall Thickness (mm)
Kingspan **Kool**therm®	100	80	100	**180**	100	100	120	**220**
Rock Fibre*	250	250	100	**350**	250	250	130	**380**
XPS**	150	150	180	**330**	150	150	215	**365**

THINNER

THICKER

**Assuming thermal conductivity 0.038 W/m·K for between & 0.036 W/m·K for over.*

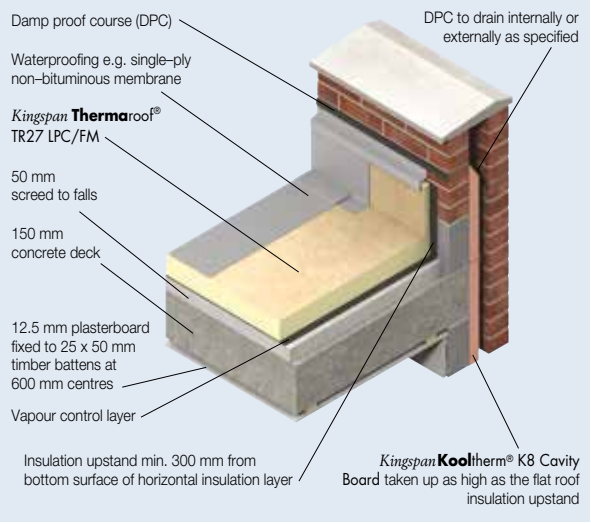
***Assuming thermal conductivity 0.036 W/m·K.*

NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume the following:

- *for 61 – 80 mm insulation thicknesses, a stainless steel fixing of cross–sectional area 7.9 mm², with 8.3 fixings per m²;*
- *for 81 – 100 mm insulation thicknesses, a stainless steel fixing of cross–sectional area 7.9 mm², with 10.0 fixings per m²;*
- *for 101– 125 mm insulation thicknesses, a stainless steel fixing of cross–sectional area 9.1 mm², with 11.1 fixings per m²;*
- *for 126 – 150 mm insulation thicknesses, a stainless steel fixing of cross–sectional area 9.1 mm², with 14.3 fixings per m²; and*
- *for insulation thicknesses > 150 mm, a stainless steel fixing of cross–sectional area 9.1 mm², with 16.7 fixings per m².*

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, regardless of rafter depth, and is less likely to have a prohibitive aesthetic effect on bargeboard / fascia board depth. There may be cost issues with the rafter depth required for some solutions.

Flat Roof – Concrete Deck with Suspended Plasterboard Ceiling



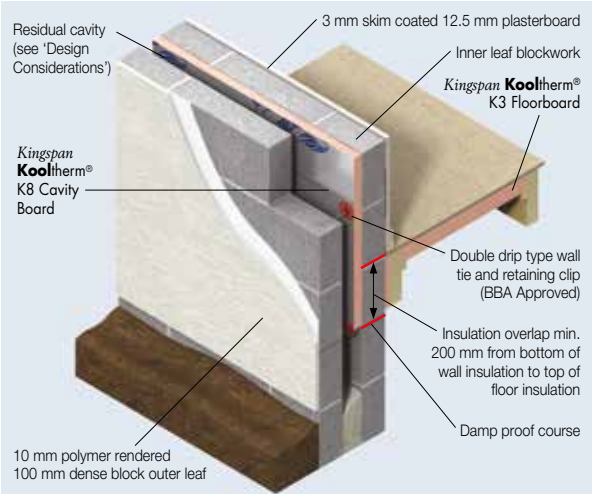
Insulation Thicknesses to Achieve Different U–values

Insulation Material	U–value (W/m²·K) 0.11 Insulation Thickness (mm)	0.11 Overall Thickness (mm)	0.10 Insulation Thickness (mm)	0.10 Overall Thickness (mm)	
Kingspan OPTIM-R™ **Roofing System*** & *Kingspan* **Thermaroof®** TR27 LPC/FM (Overlay)	65 + 25	90	70 + 25	95	THINNEST
Kingspan **Thermaroof®** TR27 LPC/FM	100 + 105	205	100 + 125	225	THINNER
Rock Fibre**	155 + 160	315	150 + 195	345	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex component of the System is taken as 10%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB These calculations assume that insulation boards are fully bonded to the vapour control layer. Where multiple layers of insulation of different thicknesses are shown, the second thickness is the overlay board.

It can be seen from the table above that in all circumstances shown, the *Kingspan* OPTIM-R™ **Roofing System** insulation thickness can be significantly less than that for rock mineral fibre – over 3 times thinner, which may allow lower parapets and shorter fixings.

Cavity Wall – Cavity Insulation Only



Insulation Thicknesses to Achieve Different U–values					
	U–value (W/m²·K)				
	0.17		0.15		
Insulation Material	Cavity Width (mm)	Insulation Thickness (mm)	Cavity Width (mm)	Insulation Thickness (mm)	
Kingspan **Kool**therm® (Partial Fill)	135	85	155	105	THINNER
Glass Fibre* (Full Fill)	185	185**	215	215**	THICKER

**Assuming thermal conductivity 0.037 W/m·K.*

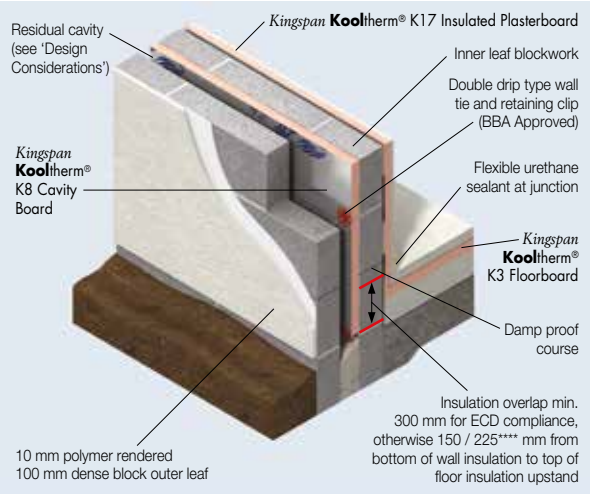
***The insulation fully, rather than partially, fills the cavity and, so, the wall tie specification will differ and no retaining clips will be present.*

NB The calculations assume lightweight blockwork with a λ–value of 0.15 W/m·K. When calculating U–values to BS EN ISO 6946: 2007, the type of wall tie used may change the thickness of insulation required. These calculations the following:

- *for 135 mm partial fill cavity widths, a stainless steel flexible tie with 4.9 ties per m² and a cross–sectional area of 23.00 mm²;*
- *for 155 mm partial fill cavity widths, a stainless steel flexible tie with 4.9 ties per m² and a cross–sectional area of 23.00 mm²;*
- *for 185 mm full fill cavity widths, a stainless steel flexible tie with 3.0 ties per m² and a cross–sectional area of 60.80 mm²; and*
- *for 215 mm full fill cavity widths, a stainless steel flexible tie with 3.0 ties per m² and a cross–sectional area of 60.80 mm².*

Cavities of just 135 and 155 mm respectively can be used with the *Kingspan* **Kool**therm® solution. In both circumstances shown in the table above, the use of the *Kingspan* **Kool**therm® solution reduces total wall width by at least 50 mm, compared with the glass mineral fibre full fill alternatives. 185 and 215 mm wide cavities may require far more onerous wall tie specifications, which will increase thermal bridging.

Cavity Wall – Cavity Insulation & Insulated Dry-Lining on Dabs



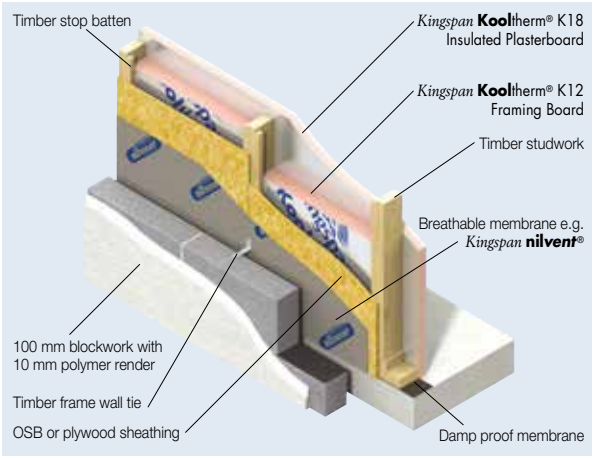
Insulation Thicknesses to Achieve Different U–values

	U–value (W/m²·K)								
	0.17				0.15				
Insulation Material	Cavity Width (mm)	Cavity Insulation Thickness (mm)	Insulated Plasterboard Thickness (mm)****	Overall Thickness (mm)	Cavity Width (mm)	Cavity Insulation Thickness (mm)	Insulated Plasterboard Thickness (mm)****	Overall Thickness (mm)	
Kingspan **Kool**therm® (Partial Fill)	100	50	47.5	147.5	100	50	57.5	157.5	THINNER
Glass Fibre* (Full Fill) & XPS** (Insulated Plasterboard)	100	100***	82.5	182.5	100	100***	107.5	207.5	THICKER

**Assuming thermal conductivity 0.037 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K.*
****The insulation fully, rather than partially, fills the cavity and, so, the wall tie specification will differ and no retaining clips will be present.*
*****All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
NB The calculations assume lightweight inner blockwork with a λ–value of 0.15 W/m·K. When calculating U–values to BS EN ISO 6946: 2007, the type of wall tie used may change the thickness of insulation required. For 100 mm cavity widths, calculations assume that a stainless steel flexible tie with 2.5 ties per m^2 and a cross–sectional area of 12.50 mm^2.

It can be seen from the table above that in all circumstances shown, the use of *Kingspan* **Kool**therm® can result in a wall construction that is thinner than the glass mineral fibre and extruded polystyrene combination solutions.

Timber Frame Wall – Insulation between Timber Studs & Insulated Dry-Lining



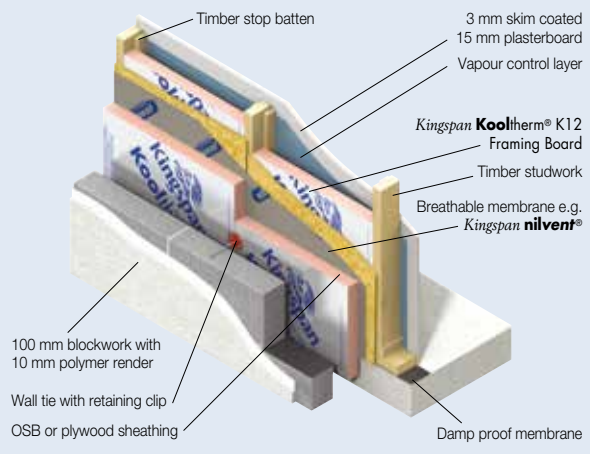
Insulation Thicknesses to Achieve Different U–values

Insulation Material	U–value (W/m²·K)								
	0.17					0.15			
	Stud Depth (mm)	Between Studs Insulation Thickness (mm)	Insulated Plasterboard Thickness (mm)******	Overall Thickness (mm)****		Stud Depth (mm)	Between Stud Insulation Thickness (mm)	Insulated Plasterboard Thickness (mm)******	Overall Thickness (mm)****	
Kingspan **Kool**therm®	140	120	32.5	**172.5**	THINNER	140	120	42.5	**182.5**	THINNER
	89	70	57.5	**146.5**		89	70	72.5	**161.5**	
Glass Fibre* (Between Studs) & XPS** (Insulated Plasterboard)	140	140***	82.5	**222.5**	THICKER	140	140	107.5	**247.5**	THICKER
Glass Fibre* (Between)	250	250	0*****	**265.0**		290	290	0*****	**305.0**	

**Assuming thermal conductivity 0.035 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K.*
****No timber stop battens as insulation fully fills studs.*
*****Including redundant air–space between studs and plasterboard thickness.*
******A different lining specification – 15 mm plasterboard.*
*******All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
NB The calculations assume dense block with a λ–value of 1.13 W/m·K, with 10 mm polymer render. When calculating U–values to BS EN ISO 6946: 2007, the type of wall tie used may change the thickness of insulation required. The effect of fixings for insulated plasterboard has been ignored in these calculations as the insulation layer penetrated is not the main insulation layer. A 15% bridging factor has been assumed for the timber stud. The thermal conductivity of the timber has been assumed to be 0.12 W/m·K.

Using *Kingspan* **Kool**therm® can result in a thinner overall construction. The glass mineral fibre solutions shown above require considerably deeper studwork to accommodate the required thickness of insulation.

Timber Frame Wall – Insulation between Timber Studs & Insulated Sheathing



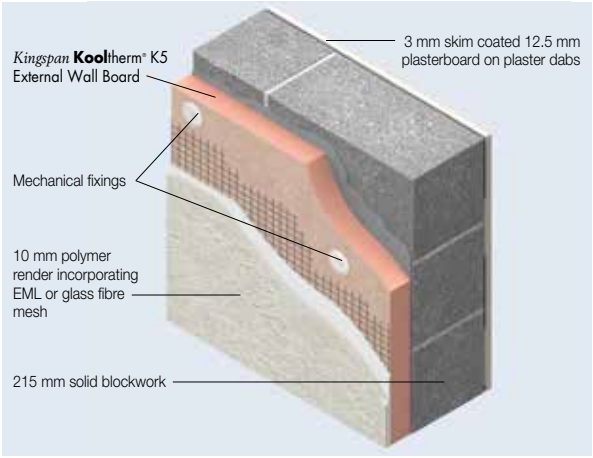
Insulation Thicknesses to Achieve Different U–values

	U–value (W/m²·K)								
	0.17				0.15				
Insulation Material	Stud Depth (mm)	Between Stud Insulation Thickness (mm)	Insulated Sheathing (mm)	Overall Thickness (mm)****	Stud Depth (mm)	Between Stud Insulation Thickness (mm)	Insulated Sheathing (mm)	Overall Thickness (mm)****	
Kingspan **Kool**therm®	89	50	50.0	139.0	89	60	60.0	149.0	THINNER
Glass Fibre* (Between Studs) & XPS** (Insulated Plasterboard)	140	140***	82.5	222.5	140	140	107.5	247.5	THICKER

**Assuming thermal conductivity 0.035 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K.*
****No timber stop battens as insulation fully fills studs.*
*****Including redundant air–space between studs and plasterboard thickness.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of wall tie used may change the thickness of insulation required. The calculations assume the use of stainless steel fasteners of cross sectional area 7.45 mm², with 4.4 fixings per m². A 15% bridging factor has been assumed for the timber stud. The thermal conductivity of the timber has been assumed to be 0.12 W/m·K.

Using *Kingspan* **Kool**therm® can result in a thinner overall construction. The glass mineral fibre solutions shown above require considerably deeper studwork to accommodate the required thickness of insulation.

Solid Blockwork Wall



Insulation Thicknesses to Achieve Different U–values			
	U–value ($W/m^2 \cdot K$)		
	0.17	0.15	
Insulation Material	Insulation Thickness (mm)	Insulation Thickness (mm)	
Kingspan OPTIM-R™ **External Wall System***	50	55	THINNEST
Kingspan **Kool**therm®	85	100	THINNER
Rock Fibre**	155	185	THICKER
EPS**	155	185	

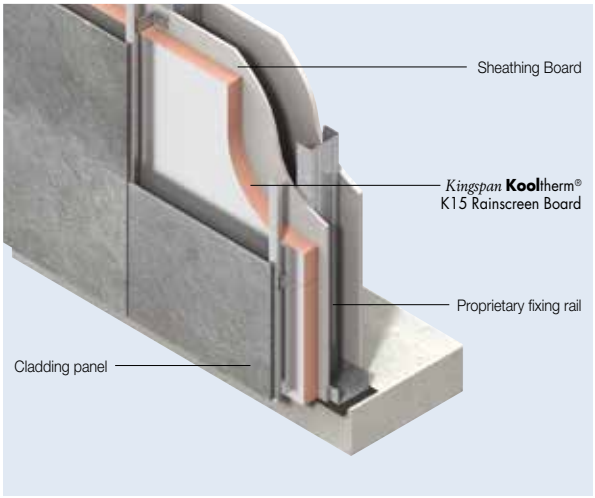
**The Kingspan OPTIM-R™ External Wall System is overlaid with a magnesium silicate render carrier board. This is mechanically fixed through the appropriate horizontal or vertical Kingspan OPTIM-R™ fix panels using carbon steel fasteners with a cross–sectional area of 7.45 mm^2, with 4.4 fasteners per m^2. The bridging effect of the Kingspan OPTIM-R™ flex & Kingspan OPTIM-R™ fix components of the System is taken as 30%.*

***Assuming thermal conductivity 0.038 W/m·K.*

NB Calculations assume lightweight block with a λ–value of 0.15 W/m·K. Calculations also assume that the Kingspan OPTIM-R™ component of the Kingspan OPTIM-R™ External Wall System is adhesively fixed to the substrate, and that all other insulation boards are mechanically fixed. When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations also assume thermally broken fasteners with a thermal conductivity 1.00 W/m·K or less, the effect of which is insignificant, for the fixing of the Kingspan OPTIM-R™ fix and Kingspan OPTIM-R™ flex components of the Kingspan OPTIM-R™ External Wall System.

Using *Kingspan* **Kool**therm® or the *Kingspan* OPTIM-R™ **External Wall System** can dramatically reduce the width of the overall wall construction compared with the alternatives shown above.

Rainscreen Cladding on Steel Frame

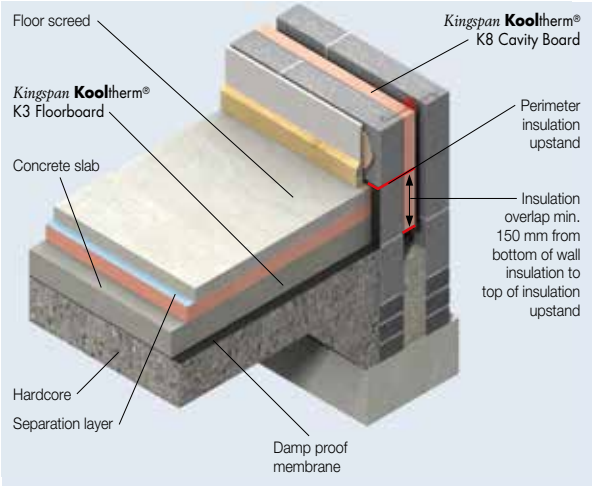


Insulation Thicknesses to Achieve Different U–values						
		U–value (W/m²·K)				
		0.17		0.15		
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	Insulation Thickness (mm)	Overall Thickness (mm)		
Kingspan OPTIM-R™ Rainscreen System*	60 + 50	110	70 + 65 (or 50 + 50 + 35)	135	THINNEST
Kingspan Kooltherm®	100 + 70	170	100 + 110	210	THINNER
Rock Fibre**	150 + 140	290	200 + 155	355	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex & Kingspan OPTIM-R™ fix components of the System is taken as 30%.*
***Assuming thermal conductivity 0.035 W/m·K.*
NB Where multiple layers of insulation of different thicknesses are shown, the second thickness is the outer layer. When calculating U–values to BS EN ISO 6946: 2007, the type of discrete 'helping hand' bracket may change the thickness of insulation required. These calculations assume carbon steel fasteners of cross–sectional area 16.98 mm² at a density of 3.13 per m².

Using *Kingspan* **Kool**therm® or the *Kingspan* OPTIM-R™ **Rainscreen System** solution can result in a dramatically thinner overall construction. The rock mineral fibre solutions shown above require considerably deeper discrete helping hand brackets to accommodate the required thickness of insulation.

Ground Floor – Solid Concrete with Insulation below Floor Screed



Insulation Thicknesses to Achieve Different U–values

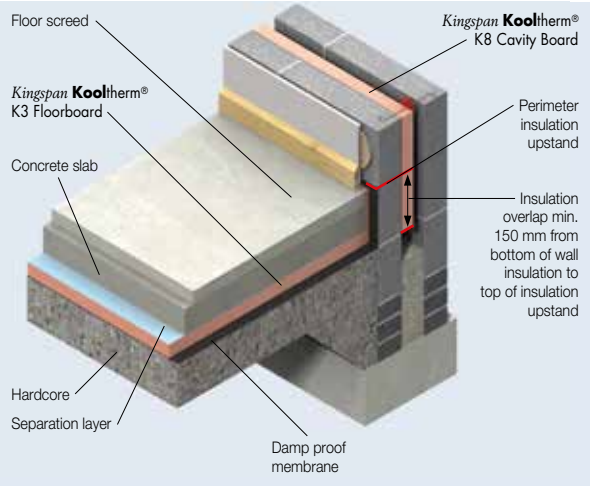
Insulation Material	U–value (W/m²·K) 0.15 Insulation Thickness (mm)	0.13 Insulation Thickness (mm)	
Kingspan OPTIM-R™ Flooring System*	50	55	THINNEST
Kingspan **Kool**therm®	100	115	THINNER
EPS**	180	225	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex & Kingspan OPTIM-R™ fix components of the System is taken as 15%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB For the purposes of these calculations, using the method as detailed in BS EN ISO 13370: 1998, the soil has been assumed to be clay or silt, and the wall insulation is assumed to overlap the floor insulation by minimum 150 mm. The P/A ratio is taken as 0.5.

Using *Kingspan* **Kool**therm® or the *Kingspan* OPTIM-R™ **Flooring System** rather than the expanded polystyrene solution, in the floor construction illustrated above, can result in having to dig out, and dispose of, less soil to make the space to accommodate the insulation.

Furthermore, if you were using expanded polystyrene floor insulation under the old regulations, simply swapping the insulant to *Kingspan* **Kool**therm® K3 Floorboard or the *Kingspan* OPTIM-R™ **Flooring System** will mean that you will not need to alter your drawings or levels and should give a good enough U-value for the purposes of compliance.

Ground Floor – Solid Concrete with Insulation below Floor Slab



Insulation Thicknesses to Achieve Different U–values			
	U–value (W/m²·K)		
	0.15	0.13	
Insulation Material	Insulation Thickness (mm)	Insulation Thickness (mm)	
Kingspan **Kool**therm®	100	115	THINNER
EPS*	180	225	THICKER

**Assuming thermal conductivity 0.038 W/m·K.*

NB For the purposes of these calculations, using the method as detailed in BS EN ISO 13370: 1998, the soil has been assumed to be clay or silt, and the wall insulation is assumed to overlap the floor insulation by minimum 150 mm. The P/A ratio is taken as 0.5.

Using *Kingspan* **Kool**therm® rather than the expanded polystyrene solution, in the floor construction illustrate above, can result in having to dig out, and dispose of, less soil to make the space to accommodate the insulation.

Furthermore, if you were using expanded polystyrene floor insulation under the old regulations, simply swapping the insulant to *Kingspan* **Kool**therm® K3 Floorboard will mean that you will not need to alter your drawings or levels and should give a good enough U-value for the purposes of compliance.

Existing Dwellings

Section 6 (energy) – Domestic provides guidance for both new elements and refurbished / retained elements.

Due to the increased complexity of refurbishing or converting buildings, particularly historic, listed or traditional buildings, the regulation does make provision for where there may be constraints on existing buildings. Whilst it is expected that developers aim for the U–values that can be found in the following sections, there is a degree of flexibility surrounding tricky refurbishments. It is advised that the individual properties of the building and the feasibility of any works are taken into account.

Conversion of Unheated Buildings

Where an existing unheated building is to be converted and heating is to be introduced, the following U–values should be targeted.

Element	Area–weighted average U–value ($W/m^2 \cdot K$) for all elements of the same type
Pitched roofs (insulation between ceiling ties or collars)	0.15
Flat or pitched roofs (insulation between rafters or roof with integral insulation)	0.18
Walls	0.22
Floors	0.18

Table 4: Conversion of an unheated dwelling

There may be instances where conversion of part of a dwelling takes place. Thought should be given to further opportunities for improvement that may arise as a result of work, for example when converting a roof space there may be a need to extend the insulation envelope and at this point it would be advantageous to upgrade any remaining poorly performing parts of the roof which are adjacent to the conversion (such as parts of the ceiling ties at the eaves).

Conversion of Heated Buildings

Where an existing heated dwelling is to be converted, the U–values shown in Table 5 should be used.

Element	Area–weighted average U–value ($W/m^2 \cdot K$) for all elements of the same type[1]	Individual element U–value ($W/m^2 \cdot K$)
Roofs	0.25	0.35
Walls	0.30	0.70
Floors	0.25	0.70

[1] *Assuming that existing walls have a U–value worse than 0.70 $W/m^2 \cdot K$*

Table 5: Conversion of an heated dwelling

Refurbishment & Extensions to the Insulation Envelope

Section 6 (energy) – Domestic sets out area weighted average U–value standards and individual element U–values for refurbishment and extensions to the insulation envelope. The provision is included to make the design of the dwelling robust should the performance of one fabric element fail or perform less well than expected.

The values should be used for renovation of thermal elements. A thermal element is defined as the part of a wall, floor or roof which separates a thermally conditioned part of the building from: the external environment; another unconditioned part of the building; or another part of the building which is used for a different purpose from the conditioned space, and is conditioned to a different temperature.

Element	Area–weighted average U–value ($W/m^2 \cdot K$) for all elements of the same type		Individual element U–value ($W/m^2 \cdot K$)
	(a) Extensions (where existing dwelling walls and roof are worse than 0.70 and 0.25 respectively)	(a) Other extensions; upgraded existing thermal elements; non–exempt conservatories	
Pitched roofs (insulation between ceiling ties or collars)	0.11	0.15	0.35
Flat or pitched roofs (insulation between rafters or roof with integral insulation)	0.13	0.18	0.35
Walls	0.17	0.22	0.70
Floors	0.15	0.18	0.70

Table 6: Refurbishing or extending the insulation envelope

Compensatory approaches may be used to vary from the above values, provided individual elements are no worse than the limiting ones.

For extensions, the performance of elements can be varied, providing that the overall heat loss from the extension is no greater than a notional one that did comply, for example an area of glazing greater than 25% of the floor area could be shown to still comply by the compensatory approach, if the performance of other elements was improved to compensate.

Where refurbishing or converting a building into a dwelling, the area weighted U–value compensatory approach can also be used to compensate for a greater area of openings than the 25% of floor area allowance. However, such a trade–off approach cannot be used where values are only being met as far as is reasonably practicable.

A whole dwelling approach can also be adopted where the existing dwelling and its extension are modelled in SAP 2012. This could show that the DER will be no higher than its TER.

Conservatories

Conservatories less than 50 m^2 are exempt from building standards. For non–exempt conservatories, please refer to Table 6. Conservatory glazing should have a maximum area–weighted average U–value of 1.8 $W/m^2 \cdot K$ and a maximum individual element U–value of 3.3 $W/m^2 \cdot K$

Ventilation

The provision of ventilation to buildings should be considered when upgrading, extending or converting dwellings. Additional guidance can be found in the Domestic Building Services Compliance Guide for Scotland and in Section 3 (environment).

Limits for Air-permeability & Building Services

Unless the SAP methodology is being used to demonstrate compliance, air–tightness testing is not necessary for work to existing buildings. A default value of 10 $m^3/hr/m^2$ at 50 Pa can be adopted.

Guidance from the 'New Dwellings' section of this document should be followed.

Linear Thermal Bridging

The building fabric should be constructed so that there are no reasonably avoidable thermal bridges: in the insulation layers caused by gaps within the various elements; at the joints between elements; and at the edges of elements such as those around windows and door openings.

Reasonable provision would be to adopt the provisions as outlined in the 'New Buildings' section of this document.

U-value Calculations

All U–values should be calculated using the methods and conventions set out in BR 443 (Conventions for U–value calculations) and should include allowances for any repeating thermal bridges.

Constructions & U-values

Set out in the following pages are constructions using Kingspan Insulation products, which are designed to meet the U–values in column (a) of Table 6. These U–values are valid for the constructions shown in the details immediately above.

Also shown, is a range of alternative solutions that other insulation manufacturers might offer.

The constructions shown do not comprise an exhaustive list of Kingspan Insulation solutions. Please contact the Kingspan Insulation Technical Service Department (see rear cover), if you require similar calculations for other constructions.

U–values have been calculated using the methods detailed in:

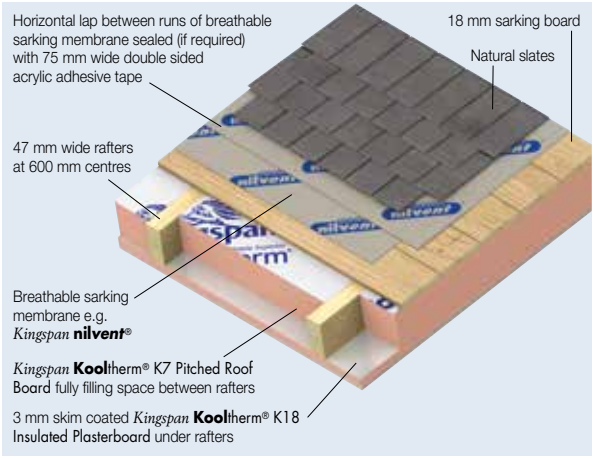
- BS EN ISO 6946: 2007 (Building components & building elements. Thermal resistance and thermal transmittance. Calculation method);
- BS EN ISO 13370: 1998 (Thermal performance of buildings. Heat transfer via the ground. Calculation methods); and
- using the conventions set out in BR 443 (Conventions for U–value calculations).

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

The figures quoted are for guidance only. A detailed U–value calculation and a condensation risk analysis should be completed for each project. Please contact the Kingspan Insulation Technical Service Department (see rear cover).

Kingspan Insulation Solutions – Existing Dwellings

Pitched Roof – Insulation Between & Under Rafters (Extensions & Existing Dwellings)

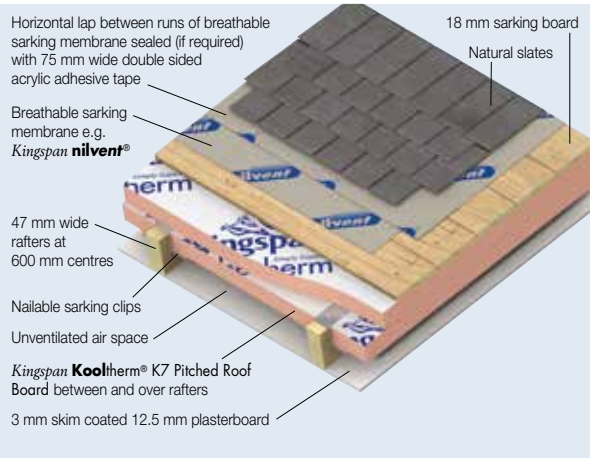


Insulation Thicknesses to Achieve a U–value of 0.13 W/m²·K					
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Under Rafter Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	
Kingspan **Kool**therm®	125	125	62.5	187.5	THINNER
Glass Fibre* (Between) & XPS** (Under)	150	150	142.5	292.5	THICKER

**Assuming thermal conductivity 0.037 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K*
****All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. The effect of fixings for the insulated plasterboard assumed in the calculations above is insignificant, since the insulation layer penetrated is not the main insulation layer.

Using *Kingspan* **Kool**therm® can result in a much thinner overall construction, regardless of rafter depth, and is likely to have a prohibitive effect on headroom. There may be severe practicality issues with fixing a 142.5 mm insulated plasterboard product. Alternatively, it could be costly and impractical to extend rafter depths.

Pitched Roof – Insulation Between & Over Rafters (Extensions & Existing Dwellings)



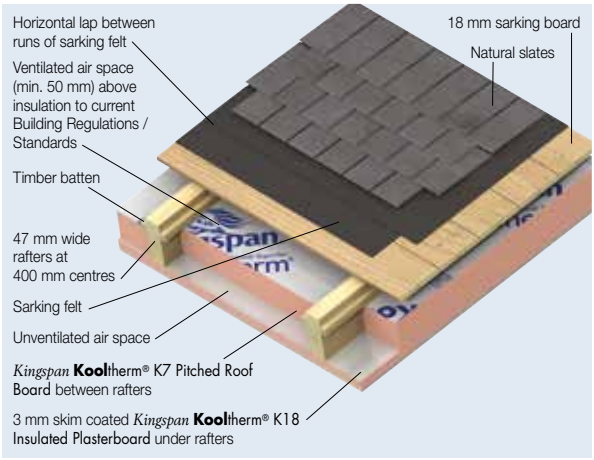
Insulation Thicknesses to Achieve a U–value of 0.13 W/m²·K					
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Over Rafter Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan **Kool**therm®	100	75	75	175	THINNER
Rock Fibre*	100	100	185	285	
XPS**	100	100	180	280	THICKER

**Assuming thermal conductivity 0.038 W/m·K for between & 0.036 W/m·K for over.*
***Assuming thermal conductivity 0.036 W/m·K.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume the following:

- *for 61 – 80 mm insulation thicknesses, a stainless steel fixing of cross–sectional area 7.9 mm², with 8.3 fixings per m²;*
- *for 81 – 100 mm insulation thicknesses, a stainless steel fixing of cross–sectional area 7.9 mm², with 10.0 fixings per m²;*
- *for 101– 125 mm insulation thicknesses, a stainless steel fixing of cross–sectional area 9.1 mm², with 11.1 fixings per m²;*
- *for 126 – 150 mm insulation thicknesses, a stainless steel fixing of cross–sectional area 9.1 mm², with 14.3 fixings per m²; and*
- *for insulation thicknesses > 150 mm, a stainless steel fixing of cross–sectional area 9.1 mm², with 16.7 fixings per m².*

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, regardless of rafter depth, and is likely to have a prohibitive aesthetic effect on bargeboard / fascia board depth. There may be cost issues with the rafter depth required for some solutions.

Pitched Roof – Loft Conversion with Insulation Between & Under Rafters (Existing Dwellings)

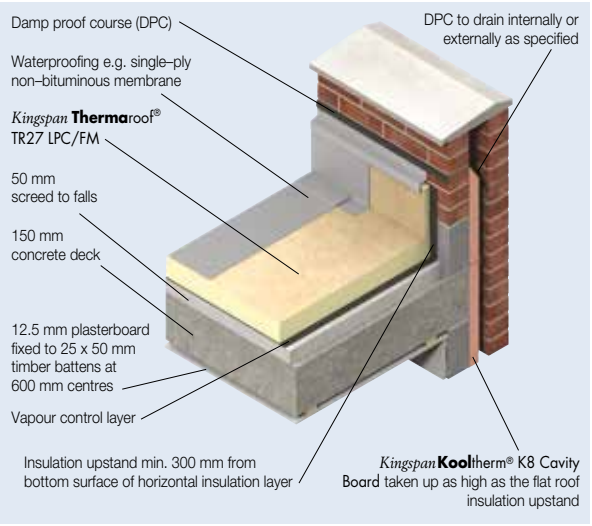


Insulation Thicknesses to Achieve a U–value of 0.13 W/m²·K					
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Under Rafter Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	
Kingspan **Kool**therm®	150	100	87.5	237.5	THINNER
Glass Fibre* (Between) & XPS** (Under)	200	150	152.5	352.5	THICKER

**Assuming thermal conductivity 0.037 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K*
****All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. The effect of fixings for Kingspan **Kool**therm® *insulated plasterboard is insignificant as the insulation layer penetrated is not the main insulation layer.*

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, regardless of rafter depth, and is less likely to have a prohibitive effect on headroom. There may be severe practicality issues with fixing a 152.5 mm insulated plasterboard product.

Flat Roof – Concrete Deck (Extensions & Existing Dwellings)

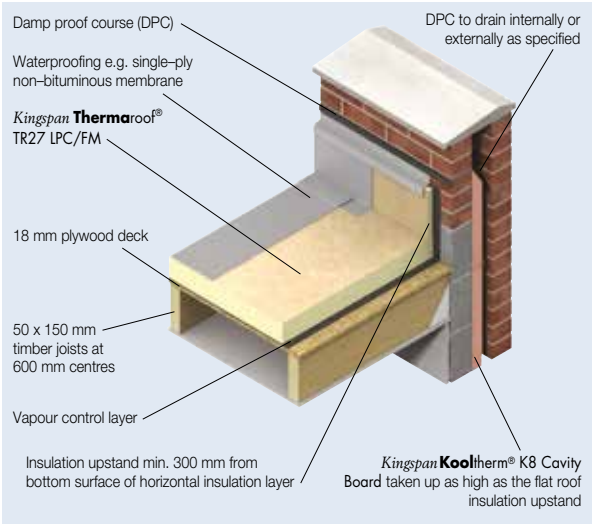


Insulation Thicknesses to Achieve a U–value of 0.13 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan OPTIM-R™ **Roofing System*** & *Kingspan* **Therma**roof® TR27 LPC/FM (Overlay)	55 + 25	80	THINNEST
Kingspan **Therma**roof® TR27 LPC/FM	120 + 50	170	THINNER
Rock Fibre**	265	265	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex component of the System is taken as 10%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB These calculations assume that insulation boards are fully bonded to the vapour control later. Where multiple layers of insulation of different thicknesses are shown, the second thickness is the overlay board.

It can be seen from the table above that the *Kingspan* OPTIM-R™ **Roofing System** insulation thickness can be significantly less than that for rock mineral fibre – over 3 times thinner, which may allow lower parapets and shorter fixings.

Flat Roof – Timber Deck (Extensions & Existing Dwellings)

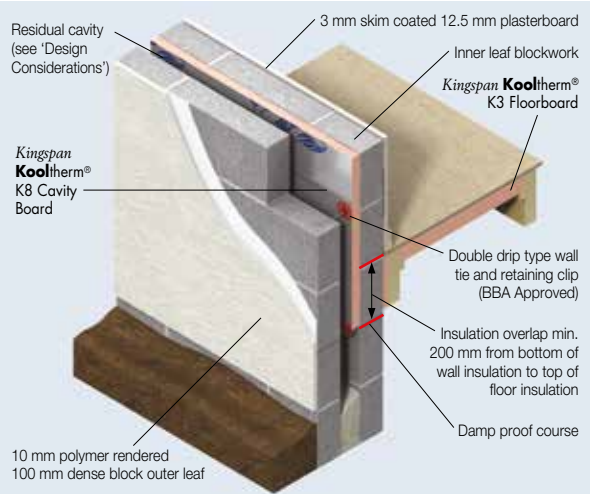


Insulation Thicknesses to Achieve a U–value of 0.13 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan OPTIM-R™ **Roofing System*** & *Kingspan* **Therma**roof® TR27 LPC/FM (Overlay)	55 + 25	80	THINNEST
Kingspan **Therma**roof® TR27 LPC/FM	120 + 50	170	THINNER
Rock Fibre**	260	260	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex component of the System is taken as 10%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB These calculations assume that insulation boards are fully bonded to the vapour control later. Where multiple layers of insulation of different thicknesses are shown, the second thickness is the overlay board.

It can be seen from the table above that *Kingspan* OPTIM-R™ **Roofing System** insulation thickness can be significantly less than that for rock mineral fibre – over 3 times thinner, which may allow lower parapets.

Cavity Wall – Cavity Insulation Only (Extensions)



Insulation Thicknesses to Achieve a Different U–value of 0.17 W/m²·K			
Insulation Material	Cavity Width (mm)	Insulation Thickness (mm)	
Kingspan **Kool**therm® (Partial Fill)	135	85	THINNER
Glass Fibre* (Full Fill)	185**	185	THICKER

**Assuming thermal conductivity 0.037 W/m·K.*

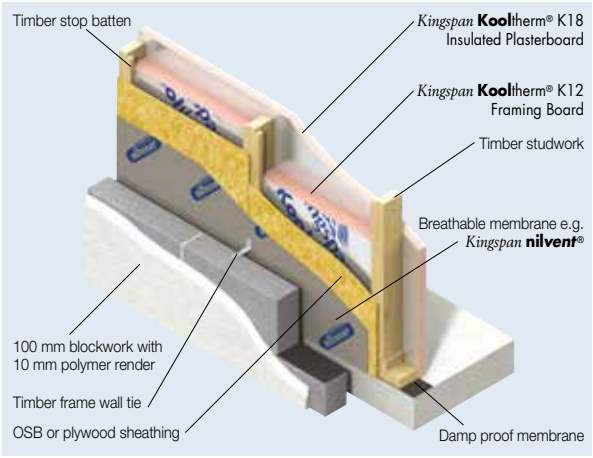
***The insulation fully, rather than partially, fills the cavity and, so, the wall tie specification will differ and no retaining clips will be present.*

NB The calculations assume lightweight blockwork with a λ–value of 0.15 W/m·K. When calculating U–values to BS EN ISO 6946: 2007, the type of wall tie used may change the thickness of insulation required. These calculations the following:

- *for 135 mm partial fill cavity widths, a stainless steel flexible tie with 4.9 ties per m² and a cross–sectional area of 23.00 mm²; and*
- *for 185 mm full fill cavity widths, a stainless steel flexible tie with 3.0 ties per m² and a cross–sectional area of 60.80 mm².*

Cavities of just 135 mm can be used with the *Kingspan* **Kool**therm® solution, reducing the total wall width by 50 mm, compared with the glass mineral fibre full fill alternative shown above.

Timber Frame Wall – Insulation between Timber Studs & Insulated Dry-Lining (Extensions)



Insulation Thicknesses to Achieve a U–value of 0.17 W/m²·K				
Insulation Material	Stud Depth (mm)	Between Studs Insulation Thickness (mm)	Insulated Plasterboard Thickness (mm)******	Overall Thickness (mm)****
Kingspan **Kool**therm®	140 89	120 70	32.5 57.5	172.5 146.5
Glass Fibre* (Between Studs) & XPS** (Insulated Plasterboard)	140	140***	82.5	222.5
Glass Fibre* (Between)	250	250	0*****	265.0

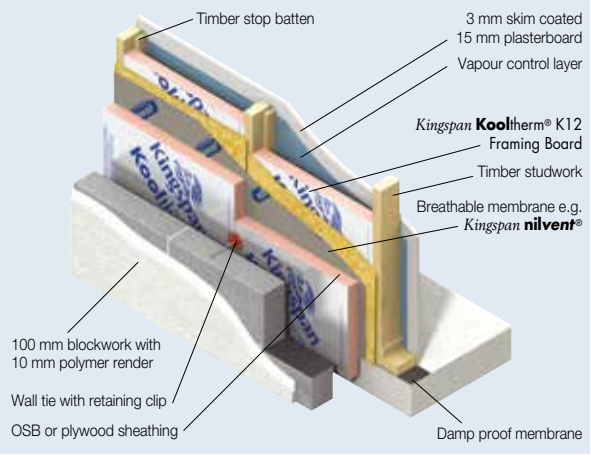
THINNER

THICKER

**Assuming thermal conductivity 0.035 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K.*
****No timber stop battens as insulation fully fills studs.*
*****Including redundant air–space between studs and plasterboard thickness.*
******A different lining specification – 15 mm plasterboard*
*******All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of wall tie used may change the thickness of insulation required. The effect of fixings for insulated plasterboard has been ignored in these calculations as the insulation layer penetrated is not the main insulation layer. A 15% bridging factor has been assumed for the timber stud. The thermal conductivity of the timber has been assumed to be 0.12 W/m·K.

Using *Kingspan* **Kool**therm® can result in a thinner overall construction. The glass mineral fibre solutions shown above require considerably deeper studwork to accommodate the required thickness of insulation.

Timber Frame Wall – Insulation between Timber Studs & Insulated Sheathing (Extensions)

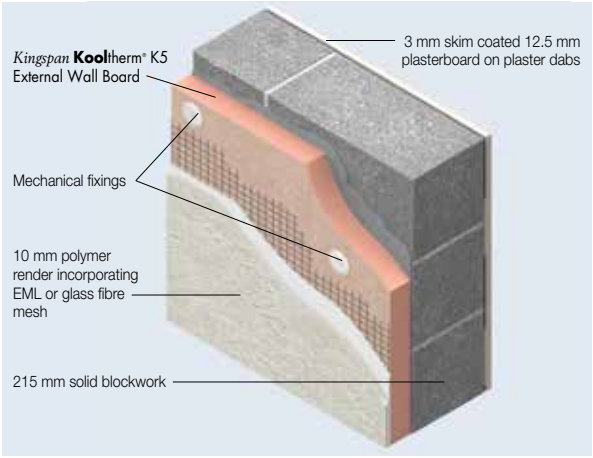


Insulation Thicknesses to Achieve a U–value of 0.17 W/m²·K					
Insulation Material	Between Studs Stud Depth (mm)	Between Studs Insulation Thickness (mm)	Insulated Sheathing	Overall Thickness (mm)****	
Kingspan **Kool**therm®	89	50	50.0	139.0	THINNER
Glass Fibre* (Between Studs) & XPS** (Insulated Sheathing)	140	140***	75.0	215.0	THICKER

**Assuming thermal conductivity 0.035 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K.*
****No timber stop battens as insulation fully fills studs.*
*****Including redundant air–space between studs and plasterboard thickness.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of wall tie used may change the thickness of insulation required. The calculations assume the use of stainless steel fasteners of cross sectional area 7.45 mm², with 4.4 fixings per m². A 15% bridging factor has been assumed for the timber stud. The thermal conductivity of the timber has been assumed to be 0.12 W/m·K.

Using *Kingspan* **Kool**therm® can result in a thinner overall construction. The glass mineral fibre solutions shown above require considerably deeper studwork to accommodate the required thickness of insulation.

Solid Blockwork Wall – External Wall Insulation (Extensions & Existing Dwellings)



Insulation Thicknesses to Achieve a U–value of 0.17 W/m²·K		
Insulation Material	Insulation Thickness (mm)	
Kingspan OPTIM-R™ External Wall System*	50	THINNEST
Kingspan Kooltherm®	85	THINNER
Rock Fibre**	155	THICKER
EPS**	155	

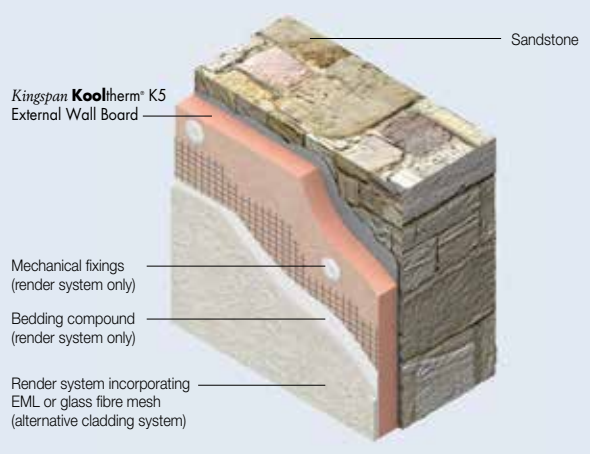
**The Kingspan OPTIM-R™ External Wall System is overlaid with a magnesium silicate render carrier board. This is mechanically fixed through the appropriate horizontal or vertical Kingspan OPTIM-R™ fix panels using carbon steel fasteners with a cross–sectional area of 7.45 mm², with 4.4 fasteners per m². The bridging effect of the Kingspan OPTIM-R™ flex & Kingspan OPTIM-R™ fix components of the System is taken as 30%.*

***Assuming thermal conductivity 0.038 W/m·K.*

NB Calculations assume lightweight block with a λ–value of 0.15 W/m·K. Calculations also assume that the Kingspan OPTIM-R™ component of the Kingspan OPTIM-R™ External Wall System is adhesively fixed to the substrate, and that all other insulation boards are mechanically fixed. When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations also assume thermally broken fasteners with a thermal conductivity 1.00 W/m·K or less, the effect of which is insignificant, for the fixing of the Kingspan OPTIM-R™ fix and Kingspan OPTIM-R™ flex components of the Kingspan OPTIM-R™ External Wall System.

Using *Kingspan* **Kool**therm® or the *Kingspan* OPTIM-R™ **External Wall System** can dramatically reduce the width of the overall wall construction compared with the alternatives shown above. In refurbishment projects, where space under the eaves may be constrained, this could be critical.

Solid Stonework Wall – External Wall Insulation (Extensions & Existing Dwellings)

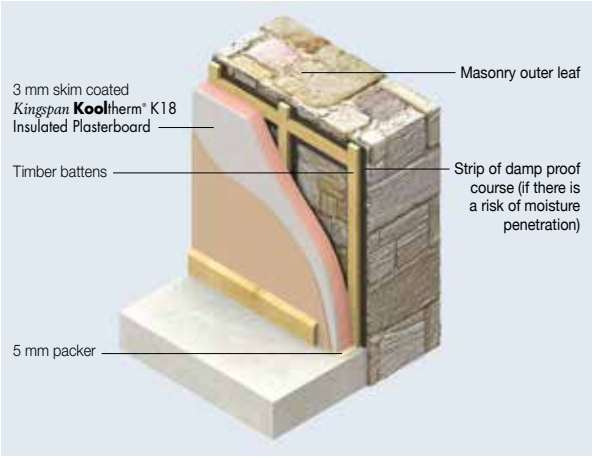


Insulation Thicknesses to Achieve a Different U–value of 0.17 W/m²·K			
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan **Kool**therm®	60 + 50	110	THINNER
Rock Fibre*	210	210	
EPS*	210	210	THICKER

**Assuming thermal conductivity 0.038 W/m·K.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume thermally broken fasteners with a thermal conductivity 1.00 W/m·K or less, the effect of which is insignificant.

Using *Kingspan* **Kool**therm® can result in a thinner overall construction, compared with the alternatives shown above. In refurbishment projects, where floor space may be constrained, this could be critical.

Solid Stonework Wall – Internal Wall Insulation (Existing Dwellings)

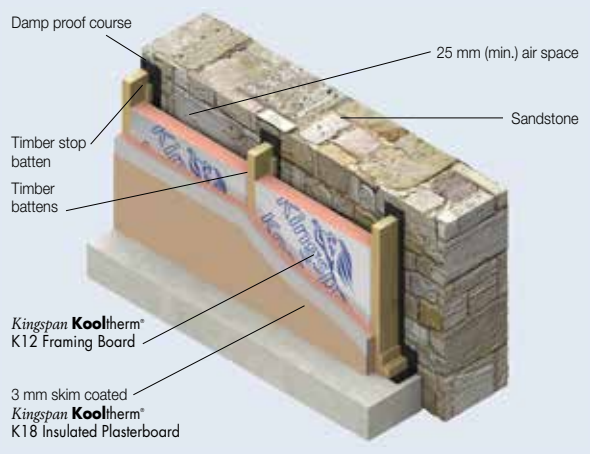


Insulation Thicknesses to Achieve a U–value W/m²·K of 0.17 W/m²·K		
Insulation Material	Insulation Thickness (mm)	
Kingspan **Kool**therm®	112.5**	THINNER
XPS	212.5***	THICKER

**Assuming thermal conductivity 0.036 W/m·K.*
***Thicknesses includes a 12.5 mm plasterboard.*
NB When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations assume the use of stainless steel fasteners of cross sectional area 7.44 mm² is assumed at a density of 4.4 per m².

Kingspan **Kool**therm® can dramatically reduce the thickness of insulation compared with the alternative shown above.
In refurbishment projects, where space under the eaves may be constrained, this could be critical.

Solid Stonework Wall – Internal Dry Lining (Existing Dwellings)

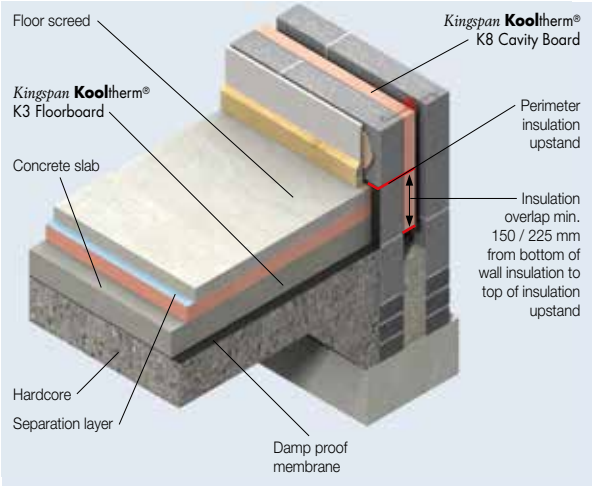


Insulation Thicknesses to Achieve a U–value of 0.17 W/m²·K					
Insulation Material	Stud Depth (mm)	Between Studs Insulation Thickness (mm)	Inside Battens Insulation Thickness (mm)***	Overall Thickness (mm)	
Kingspan **Kool**therm®	100	75	62.5	162.5	THINNER
Glass Fibre* (Between) & XPS** (Inside)	140	140	92.5	232.5	THICKER

**Assuming thermal conductivity 0.035 W/m·K.*
***Assuming thermal conductivity 0.036 W/m·K.*
****All insulated plasterboard thicknesses include 12.5 mm plasterboard.*
NB A 15% bridging factor has been assumed for the timber stud framework. The thermal conductivity of the timber has been assumed to be 0.12 W/m·K. When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used may change the thickness of insulation required. These calculations also assume thermally broken fasteners with a thermal conductivity of 1.00 W/m·K or less, the effect of which is insignificant.

Kingspan **Kool**therm® can dramatically reduce the thickness of insulation compared with the alternative shown above. In refurbishment projects, where space under the eaves may be constrained, this could be critical.

Ground Floor – Solid Concrete with Insulation below Floor Screed (Extensions & Existing Dwellings)

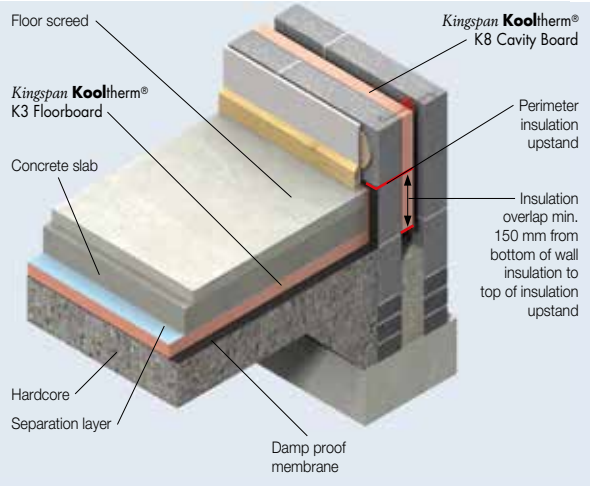


Insulation Thicknesses to Achieve Different U–values		
	0.15	
Insulation Material	Insulation Thickness (mm)	
Kingspan OPTIM-R™ Flooring System*	50	THINNEST
Kingspan **Kool**therm®	100	THINNER
EPS**	180	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex & Kingspan OPTIM-R™ fix components of the System is taken as 15%.*
***Assuming thermal conductivity 0.038 W/m·K.*
NB For the purposes of these calculations, using the method as detailed in BS EN ISO 13370: 1998, the soil has been assumed to be clay or silt, and the wall insulation is assumed to overlap the floor insulation by minimum 150 mm. The P/A ratio is taken as 0.5.

Using *Kingspan* **Kool**therm® or the *Kingspan* OPTIM-R™ **Flooring System** rather than the expanded polystyrene solution, in the floor construction illustrated above, can result in having to dig out, and dispose of, less soil to make the space to accommodate the insulation.

Ground Floor – Solid Concrete with Insulation below Floor Slab (Extensions)



Insulation Thicknesses to Achieve Different U–values		
	U–value (W/m²·K)	
	0.15	
Insulation Material	Insulation Thickness (mm)	
Kingspan **Kool**therm®	100	THINNER
EPS*	180	THICKER

**Assuming thermal conductivity 0.038 W/m·K.*
NB For the purposes of these calculations, using the method as detailed in BS EN ISO 13370: 1998, the soil has been assumed to be clay or silt, and the wall insulation is assumed to overlap the floor insulation by minimum 150 mm. The P/A ratio is taken as 0.5.

Using *Kingspan* **Kool**therm® rather than the expanded polystyrene solution, in the floor construction illustrate above, can result in having to dig out, and dispose of, less soil to make the space to accommodate the insulation.

Furthermore, if you were using expanded polystyrene floor insulation under the old regulations, simply swapping the insulant to *Kingspan* **Kool**therm® K3 Floorboard will mean that you will not need to alter your drawings or levels and should give a good enough U-value for the purposes of compliance.

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