Insulation

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Building Regulations for the Conservation of Fuel & Power

WALES - NEW DWELLINGS

2014 EDITION

Kingspan®

Low Energy – Low Carbon Buildings

Contents

Introduction

Approved Documents L

Approved Documents L (ADL), published by the Welsh Government (Llywodraeth Cymru), provide practical guidance on ways of complying with the energy efficiency requirements of the Building Regulations 2010, as amended, for building work carried out in Wales.

There are four Approved Documents L:

- Approved Document L1A: Conservation of fuel & power in new dwellings (ADL1A);
- Approved Document L1B: Conservation of fuel & power in existing dwellings (ADL1B);
- Approved Document L2A: Conservation of fuel & power in new buildings other than dwellings (ADL2A); and
- Approved Document L2B: Conservation of fuel & power in existing buildings other than dwellings (ADL2B).

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

About this Document

Kingspan Insulation has produced this document as a simple guide to the 2014 edition of ADL1A for use in Wales, including the salient changes from the 2010 edition, which was for use in both England & Wales. It specifically concentrates on the parts that are relevant to 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.

Approved Document L1A – New Dwellings

Introduction

ADL1A gives guidance on ways of demonstrating 'reasonable provision' for compliance with the energy efficiency requirements of the Building Regulations, for building work carried out to 'new dwellings'. A dwelling can be defined as a 'self–contained unit designed to accommodate a single household'.

The 2014 edition of ADL1A came into effect on 31st July 2014. The guidance given is applicable to non–exempt building work originating from plans and notices submitted to a building control body (BCB) for approval on or after this date.

Types of Work Covered

ADL1A is applicable to new dwellings. This includes indoor swimming pools that are constructed as part of the dwelling, and conservatories and / or porches that: are constructed at the same time as the dwelling; thermally separated from the dwelling; and heated by a fixed heating system.

There are however, some instances where ADL1A indicates that it may be more appropriate to follow the guidance given in ADL2A or ADL1B. These are:

- material change of use of all or part of a building – ADL1B should be used where a dwelling is created in an existing building e.g. a shop that is converted to a flat;
- mixed–use developments and multi–residential buildings – ADL2A should be used for the parts of the building that are not dwellings e.g. commercial or retail spaces, a caretakers office within a block of apartments and heated common areas (NB unheated common areas in residential buildings containing multiple dwellings should meet the area weighted limiting fabric standards detailed in Table 3 – see the 'Limits on Design Flexibility' section of this document), whereas ADL1A should be used for the individual dwellings contained within the larger building;
- buildings containing rooms for residential purposes – ADL2A should be used since such buildings e.g. nursing homes and student accommodation in halls of residences, are not considered dwellings;
- buildings containing space for both living accommodation and commercial use (i.e. live–work units) – ADL1A should be used if the commercial part of the building could revert to domestic use e.g. a home office in a house where both spaces are contained within the same heated space, there is direct access between the two spaces and much of the total area comprises the living accommodation; and
- new conservatories and / or porches utilising a fixed heating system that is either independent of, or dependent on the dwelling – ADL1B should be used where the conservatory and / or porch is constructed as an addition to an existing dwelling, and ADL1A should be used where construction takes place at the same time as a new dwelling.

Compliance with the Building Regulations

Demonstrating Compliance

ADL1A gives criteria that must be met in order to demonstrate compliance with the energy efficiency requirements of the Building Regulations. 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 emission rate for the whole of the 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).

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

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 with the energy efficiency requirements can comprise the results of calculations carried out using approved SAP 2012 compliant software.

ADL1A recommends that two versions of the evidence are presented to the BCB in a standardised format. The first version should be submitted at pre–construction ('as designed') stage not less than one day before commencement of the works, and the second at post–construction ('as built') stage not more than five days after completion of the works.

Both the 'as designed' and 'as built' submissions should include both the TER and DER calculations as well as a list of specifications, whilst demonstrating how they are met. NB The 'as built' submission should also include the assessed air–permeability, where appropriate, of the dwelling and any deviations from the 'as designed' specifications.

The two submissions can be compared and used by the BCB to assist in checking whether what has been built matches what has been designed. A clear connection should be made between the data input into the compliance software and the product specifications e.g. the type of wall construction that delivers the claimed U–value.

The calculations for the 'as built' submission may be used to provide information for the preparation of the Energy Performance Certificate (EPC) for the completed dwelling.

CO_2 Emissions

ADL1A 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/m^2/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 in accordance with SAP 2012. The thermal mass of the dwelling and minor heat gains from different sources, e.g. the sun, the occupants, household appliances and artificial lighting are also considered in the calculations.

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 ADL1A 2014 notional dwelling specification is summarised in Appendix B of ADL1A and detailed in Appendix R of SAP 2012. The main elements of the concurrent specification of the notional dwelling that relate to the opaque building fabric are shown in Table 1.

Element	Value
All Roofs	0.13 W/m^2·K
Walls	0.18 W/m^2·K
Floors	0.13 W/m^2·K
Party Walls	0.00 W/m^2·K
Windows, Roof Windows, Glazed Rooflights & Glazed Doors	1.40 W/m^2·K / g–value 0.63
Opaque Doors	1.00 W/m^2·K
Semi Glazed Doors	1.20 W/m^2·K
Air–tightness	5.00 m^3/hr/m^2 at 50 Pa
Linear Thermal Transmittance	Standardised ψ–values (see Appendix R of SAP 2012)
Thermal Mass	Medium

Table 1: Selected Reference Values from the ADL1A 2014 Notional Dwelling Specification

Calculating the TER

The TER is calculated as follows. The CO_2 emission rate from a notional dwelling of the same size and shape as the actual dwelling is calculated, using the notional building specification. The CO_2 emission rate from the proposed space heating and hot water (C_H), pumps and fans (C_{PF}) and internal lighting (C_L) are calculated separately. The TER is then calculated using the following formula:

$$TER_{2014} = C_H \times FF + C_{PF} + C_L$$

where FF is the fuel factor as shown in Table 2:

Fuel Type	Fuel Factor
Mains Gas	1.00
LPG	1.06
Oil	1.17
B30K	1.00
Grid Electricity	1.55
Solid Mineral Fuel	1.35
Solid Multi Fuel	1.00
Any Fuel with CO_2 Emission Factor Less than that of Mains Gas	1.00

Table 2: Fuel Factor for Different Fuel Types

For buildings containing multiple dwellings e.g. terraced houses or apartments, an optional method may be selected when calculating the TER for all dwellings in the building. If this method is adopted, the floor area weighted average of all individual TER's of the dwellings contained within the larger building can be calculated using the formula:

$$\frac{(TER_1 \times \text{Floor Area}_1) + (TER_2 \times \text{Floor Area}_2) + (TER_3 \times \text{Floor Area}_3)}{(\text{Floor Area}_1 + \text{Floor Area}_2 + \text{Floor Area}_3)}$$

Achieving the TER

The pre–construction DER calculation should be carried out by a competent energy assessor and presented to the BCB along with a list of specifications, so as to indicate that the dwelling, 'as designed', is compliant and to generate a list of features critical to compliance.

The post–construction, or final, DER, which should be carried out by an On Construction Domestic Energy Assessor (OCDEA), is calculated using the performance standards of the actual dwelling. For the purpose of demonstrating compliance, the final DER calculation must be based upon the dwelling 'as built' and must not only include any changes made to the performance specification during construction, but also the assessed air–permeability, which is determined as follows:

- where the dwelling has been pressure tested, the assessed air–permeability is the measured air–permeability;
- where the dwelling has not been tested, the assessed air–permeability is the average test result obtained from other dwellings of the same dwelling type on the development, but increased by a margin of 2.0 $m^3/hr/m^2$ at 50 Pa; or
- on small developments (two units or less), where the builder has opted to avoid testing, the assessed air–permeability is 15 $m^3/hr/m^2$ at 50 Pa.

For buildings containing multiple dwellings, compliance may be achieved by demonstrating that either:

- the individual DER for each dwelling is no worse than the corresponding TER; or
- the average DER for all dwellings is no worse than the corresponding TER.

If the latter method is adopted, the floor area weighted average of all the individual DER's for each dwelling contained within the larger building can be calculated using the formula:

$$\frac{(DER_1 \times \text{Floor Area}_1) + (DER_2 \times \text{Floor Area}_2) + (DER_3 \times \text{Floor Area}_3)}{(\text{Floor Area}_1 + \text{Floor Area}_2 + \text{Floor Area}_3)}$$

It is important to note that if the floor area weighted average method is adopted, it cannot be used across multiple separate buildings on a site and it is still necessary to provide information for each individual dwelling.

Indoor Swimming Pools

Where a swimming pool is built as part of a new dwelling, the dwelling should be assessed as though the pool basin is not present. The pool hall however, should be included in the TER and BER calculations. For the purpose of calculating the CO_2 emissions, the area covered by the pool basin should be treated as an equivalent area of floor with a U–value equivalent to that of the pool surround and, as shown in Table 3, no worse than 0.18 $W/m^2{\cdot}K$, calculated in accordance with BS EN ISO 13370 (Thermal performance of buildings. Heat transfer via the ground. Calculation methods).

Limits on Design Flexibility

Limiting Fabric Standards

ADL1A 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 fabric element types are shown in Table 3. 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 3 are **not** the U–values that should be adopted for compliance with the Building Regulations. For guidance, see the 'Simplifying the Complex' section of this document.

Fabric Element	Area Weighted Average U–value ($W/m^2 \cdot K$)
Roofs	0.15
Walls	0.21
Floors & Indoor Swimming Pool Basins	0.18
Party Walls	0.20
Windows, Roof Windows, Rooflights & Doors	1.60

Table 3: Area Weighted Limiting Fabric Parameters

Limits for Air–Permeability & Fixed Building Services

A limiting value of 10 $m^3/hr/m^2$ at 50 Pa is set for air–permeability. In addition, limits are also given for the energy performance of the fixed building services installed in the dwelling, the minimum energy efficiency standards for which are set out in the Domestic Building Services Compliance Guide.

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 in the continuity of the layers; at the joints between elements (junctions) e.g. where the external wall meets the ground floor; and at the edges of elements such as those around windows and door openings.

Reasonable provision in the DER calculation would be to:

a. adopt design details such as those set out in the DCLG Accredited Construction Details (ACDs) or those that are formally recognised by the Welsh Government, in which case the calculated linear thermal transmittance values (referred to as 'psi–values' and expressed as 'ψ–values') can be used directly in the calculation;

b. use construction joint details with ψ–values, (which can be used directly in the calculation) and temperature factors that have been calculated by a person with suitable expertise and experience, following the guidance set out in BRE Report BR 497 (Conventions for calculating linear thermal transmittance & temperature factors), with calculated temperature factors no worse than the performance set out in BRE IP 1/06 (Assessing the effects of thermal bridging at junctions and around openings);

c. use the ψ–values from the default column in Table K1 of SAP 2012 directly in the calculation;

d. use a conservative default y–value (whole dwelling thermal bridging allowance) of 0.15 $W/m^2{\cdot}K$, rather than ψ–values for each junction, in the calculation (NB If this value is taken, then a y–value of 0.05 $W/m^2{\cdot}K$ will be used in the TER calculation); or

e. use a combination of a, b and c.

The effect of using ψ–values that are poorer than those used for setting the TER, is that improved standards will be required elsewhere in the design, in order to compensate.

The thermal transmittance values in the ADL1A 2014 notional dwelling specification are much more stringent than the thermal transmittances defined in the 2007 edition of Accredited Construction Details (ACDs). As a consequence, the designer will have to compensate for those poorer performing junctions elsewhere in the fabric if the latter is adopted.

With increasing importance being placed upon reducing the performance gap between as–built and designed, the builder should be able to demonstrate to the BCB that an appropriate system of site inspection is in place to give confidence that the construction procedures achieve the required standards of consistency, particularly when using details as determined in 'a' and 'b' above.

Approved Document L1A – New Dwellings

Air-Permeability Testing

On each separate development, an air–pressure test should be carried out on three units of each dwelling type, or 50% of all dwellings of that type, whichever is less. Note that a block of flats should be treated as a separate development, irrespective of the number of blocks on the site. Furthermore, ground, mid or top floor flats in each individual block are considered a separate dwelling type.

The dwellings that are to be tested should be selected from the first completed batch of units of each dwelling type.

The specific dwellings that comprise the test sample should be selected by the BCB in consultation with the pressure tester. They should be selected so that about half of the scheduled tests for each dwelling type are carried out during the construction phase of the first 25% of each dwelling type. The results of all tests on dwellings in the sample should be reported to the BCB, including any test failures.

Compliance with the requirements would be demonstrated if:

- the measured air–permeability is no worse than the limiting value of 10 $m^3/hr/m^2$ at 50 Pa; and
- the DER calculated using the measured air–permeability is no worse than the TER.

If satisfactory performance is not achieved, then remedial measures should be carried out on the dwelling and a new test carried out until it achieves the criteria set out above. In addition, a further dwelling of the same dwelling type should be tested, thereby increasing the overall sample size.

In addition to the remedial work on a dwelling that has failed the initial test, other dwellings of the same dwelling type that have not been tested should be examined and, where appropriate, similar remedial measures applied.

If a development has no more than two dwellings, then the developer can either: demonstrate that during the preceding twelve month period, a dwelling of the same dwelling type has achieved the designed air–permeability; or 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.

Other Requirements

ADL1A also contains requirements for the analysis of the feasibility of high efficiency alternative systems e.g. heat pumps or renewable energy powered district heating or cooling, the avoidance of overheating caused by excessive solar gains, the commissioning of heating and hot water systems and the provision of operating and maintenance instructions.

Furthermore, ADL1A requires the use of adequate and proper materials when carrying out building work, which must be executed in such a manner that a good standard of workmanship is achieved.

Simplifying the Complex

The ADL1A 2014 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 target, as well as the limiting values for individual fabric elements and fixed building services.

Nonetheless, there is still huge scope for flexibility, should developers want it. Developers can, if they prefer, choose to diverge from the ADL1A 2014 notional dwelling specification, so long as the dwelling 'as built' achieves, or exceeds, the TER and limiting values.

Indeed the ADL1A 2014 notional dwelling specification has been strengthened to deliver an 8% reduction in the CO_2 emission rate across the new homes build mix relative to ADL1A 2010. This reduction is manifested in the ADL1A 2014 notional dwelling specification by much tougher linear thermal transmittance values and a lower air–tightness value.

At present, a set of standard details to achieve the new linear thermal transmittances (e.g. 2014 ACDs) does not currently exist and, at the time of writing, is unlikely to be developed by DCLG in the near future. Likewise, adopting an air–permeability rate of 5 $m^3/hr/m^2$ at 50 Pa in the DER calculation is a risk for developers since the tested sample of dwellings would have to achieve 3 $m^3/hr/m^2$ at 50 Pa in order that the untested dwellings comply.

This is an onerous target and current guidance is that dwellings with such high levels of air–tightness, necessitate the installation of mechanical ventilation with heat recovery systems.

The most practical route forward for developers may well be to continue to work with an air–permeability target of 7 $m^3/hr/m^2$ at 50 Pa and to continue to adopt the 2007 ACDs, whilst compensating by adopting better fabric U–values than suggested by the ADL1A 2014 notional dwelling specification.

Modelling carried out by Kingspan Insulation suggests that the values shown in Table 4 are the best starting point U–values if adopting this latter approach.

Element	U–value ($W/m^2 \cdot K$)
All Roofs	0.11
Walls	0.16
Floors	0.11

Table 4: Best Starting Point U–values

Kingspan Insulation Solutions

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 ADL1A 2014 notional dwelling specification, see Table 1; or
- the best starting point U–values, see Table 4, should the specification diverge from that given in the ADL1A 2014 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.

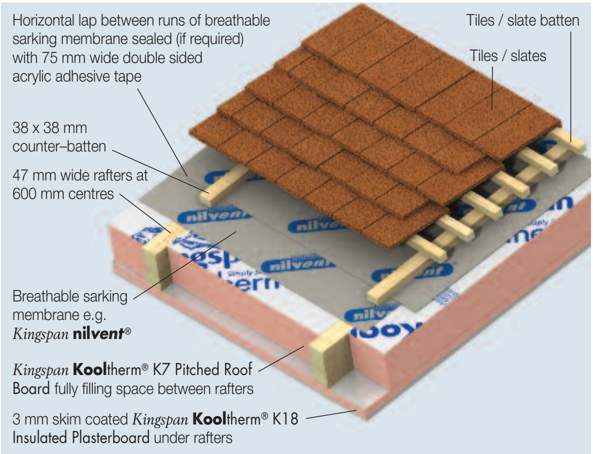
U–values have been calculated using the methods detailed in:

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



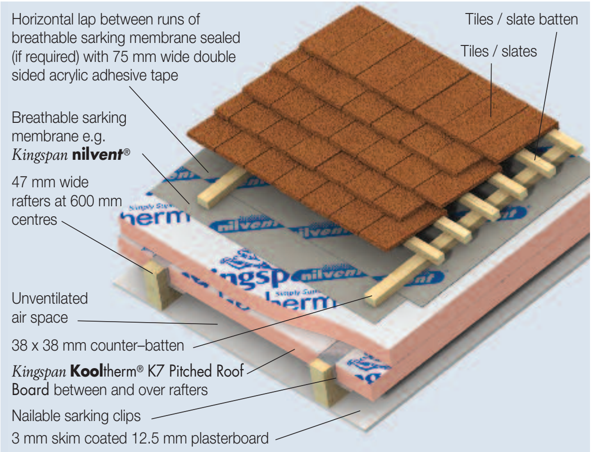
Insulation Thicknesses to Achieve Different U–values									
	U–value (W/m²·K)								
	0.13				0.11				
Insulation Material	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Under Rafter Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	Rafter Depth (mm)	Between Rafter Insulation Thickness (mm)	Under Rafter Insulated Plasterboard Thickness (mm)***	Overall Thickness (mm)	
Kingspan **Kool**therm®	100	100	82.5	**182.5**	125	125	92.5	**217.5**	THINNER
	125	125	62.5	**187.5**	150	150	72.5	**222.5**	
Glass Fibre* (Between) & XPS** (Under)	150	150	152.5	**302.5**	175	175	172.5	**347.5**	THICKER
	175	175	132.5	**307.5**	200	200	152.5	**352.5**	

**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 152.5 or 172.5 mm insulated plasterboard product.

Pitched Roof – Insulation Between & Over Rafters



Insulation Thicknesses to Achieve Different U–values								
	U–value (W/m²·K)							
	0.13				0.11			
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	75	80	**155**	100	80	100	**180**
Rock Fibre*	220	220	80	**300**	250	250	100	**350**
XPS**	150	150	130	**280**	150	150	180	**330**

THINNER

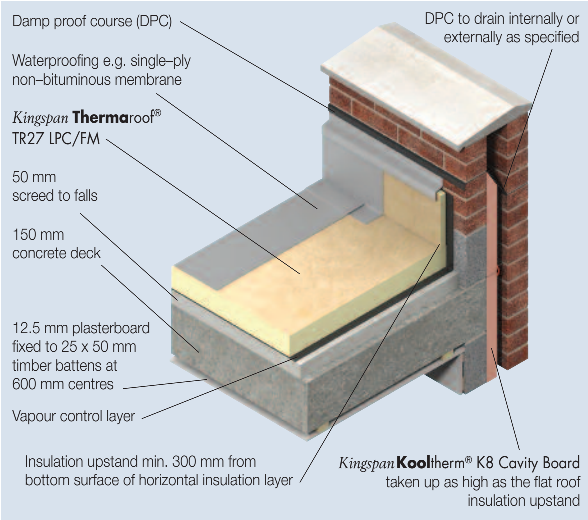
THICKER

**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 that the layers of insulation over the rafters are fixed using stainless steel fixings of cross–sectional area 7.45 mm^2, with 8.3 fixings per m^2 (insulant thickness 61–80 mm) and 10.0 fixings per m^2 (insulant thickness > 80 mm).

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					
	U–value (W/m²·K)				
	0.13		0.11		
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan OPTIM-R™ Roofing System* & *Kingspan* **Therma**roof® TR27 LPC/FM (Overlay)	55 + 25	80	65 + 25	90	THINNEST
Kingspan **Therma**roof® TR27 LPC/FM	85 + 90	175	100 + 105	205	THINNER
Rock Fibre**	135 + 135	270	150 + 160	310	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex component of the System is taken as 10%.*

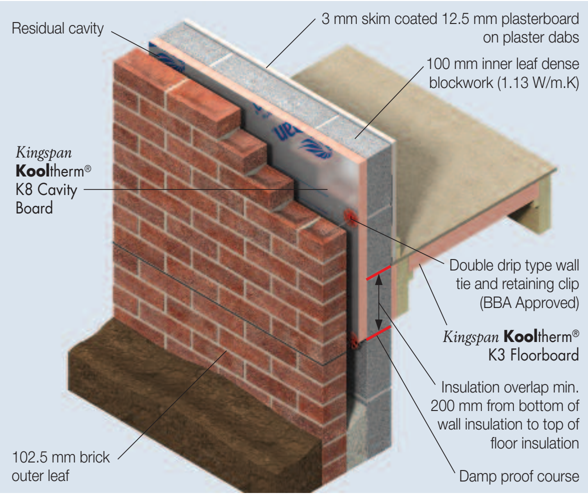
***Assuming thermal conductivity 0.038 W/m·K.*

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.

Furthermore, the weight of the insulation in the rock mineral fibre solution, shown above, may be over 7 times than that for the *Kingspan* **Therma**roof® solution. The manual handling and roof loading implications of this weight should be carefully considered.

Cavity Wall – Cavity Insulation Only



Insulation Thicknesses to Achieve Different U–values					
	U–value (W/m²·K)				
	0.18		0.16		
Insulation Material	Insulation Thickness (mm)	Overall Cavity Width (mm)	Insulation Thickness (mm)	Overall Cavity Width (mm)	
Kingspan **Kool**therm® (Partial Fill)	75	125	100	150	THINNER
Glass Fibre* (Full Fill)	175**	175	200**	200	THICKER

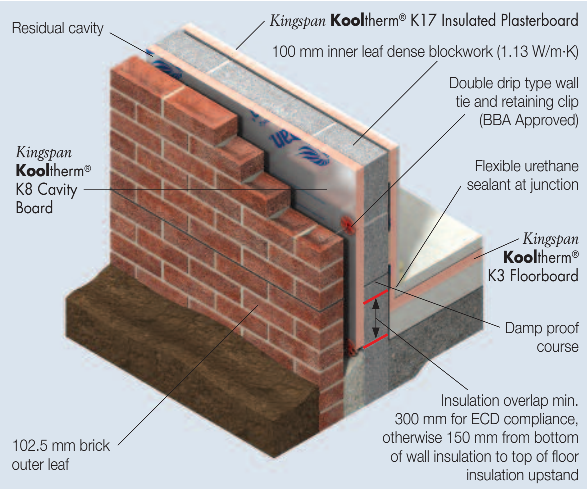
**Assuming thermal conductivity 0.037 W/m·K.*
***The insulation fully, rather than partially, fills the cavity and, so, the wall tie specification will differ and no retaining clips will be present.*

NB 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 assume 2.5 ties per m² and the following:

- *for 125 mm cavity widths, a stainless steel flexible tie of cross–sectional area 12.50 mm²;*
- *for 150 mm cavity widths, a stainless steel flexible tie of cross–sectional area 23.00 mm²;*
- *for 175 mm full fill cavity widths, a stainless steel flexible tie of cross–sectional area 30.00 mm²; and*
- *for 200 mm full fill cavity widths, a stainless steel flexible tie of cross–sectional area 60.80 mm².*

Cavities of just 125 and 150 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 50 mm, compared with the glass mineral fibre full fill alternatives. 175 and 200 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



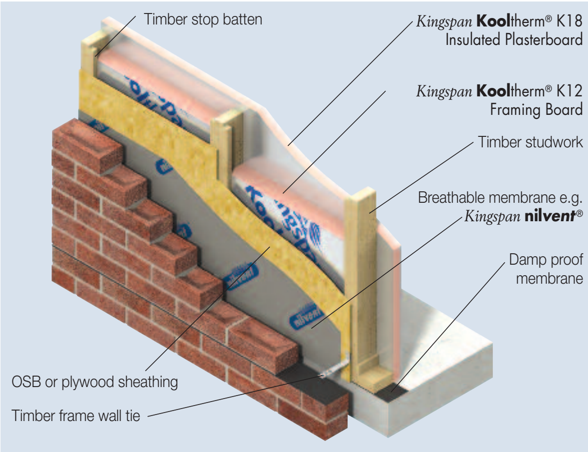
Insulation Thicknesses to Achieve Different U–values									
	U–value (W/m²·K)								
	0.18				0.16				
Insulation Material	Cavity Insulation Thickness (mm)	Cavity Width (mm)	Insulated Plasterboard Thickness (mm)****	Overall Thickness (mm)	Cavity Insulation Thickness (mm)	Cavity Width (mm)	Insulated Plasterboard Thickness (mm)****	Overall Thickness (mm)	
Kingspan **Kool**therm® (Partial Fill)	50	100	37.5	**137.5**	50	100	52.5	**152.5**	THINNER
Glass Fibre* (Full Fill) & XPS** (Insulated Plasterboard)	100***	100	72.5	**172.5**	100***	100	102.5	**202.5**	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 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 a stainless steel flexible tie of cross-sectional area 12.50 mm², with 2.5 ties per m².

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 49% thinner than the glass mineral fibre and extruded polystyrene combination solutions.

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



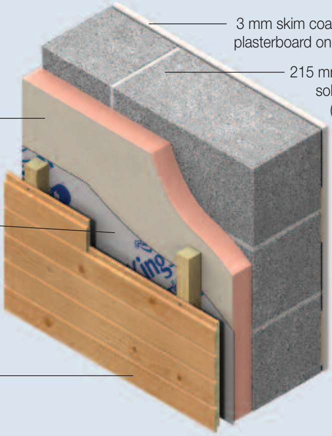
Insulation Thicknesses to Achieve Different U–values									
	U–value (W/m^2·K)								
	0.18				0.16				
Insulation Material	Between Studs Insulation Thickness (mm)	Stud Depth (mm)	Insulated Plasterboard Thickness (mm)******	Overall Thickness (mm)****	Between Stud Insulation Thickness (mm)	Stud Depth (mm)	Insulated Plasterboard Thickness (mm)******	Overall Thickness (mm)****	
Kingspan **Kool**therm®	70	89	52.5	**141.5**	70	89	72.5	**161.5**	THINNER
Glass Fibre* (Between Studs) & XPS** (Insulated Plasterboard)	140***	140	72.5	**212.5**	140***	140	97.5	**237.5**	THICKER
Glass Fibre* (Between)	235	235	0*****	**250.0**	270	270	0*****	**285.0**	

**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 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 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.

Solid Blockwork Wall – External Wall Insulation



Insulation Thicknesses to Achieve Different U–values

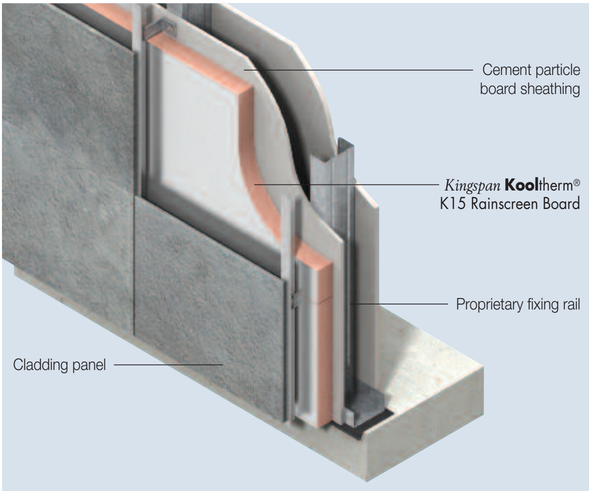
Insulation Material	U–value (W/m²·K) 0.18 Insulation Thickness (mm)	0.18 Overall Thickness (mm)	0.16 Insulation Thickness (mm)	0.16 Overall Thickness (mm)	
Kingspan OPTIM-R™ External Wall System*	45	45	50	50	THINNEST
Kingspan **Kool**therm®	75	75	90	90	THINNER
Rock Fibre**	145	145	170	170	THICKER
EPS**	145	145	170	170	

**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 These calculations assume that the Kingspan OPTIM-R™ component of the Kingspan OPTIM-R™ External Wall System *is adhesive –fixed / adhesive–restrained to the substrate, and that all other insulation boards (including the Kingspan OPTIM-R™ fix component of the Kingspan OPTIM-R™* External Wall System*) are mechanically fixed using thermally broken fasteners with a thermal conductivity 1.00 W/m·K or less, the effect of which is insignificant. When calculating U–values to BS EN ISO 6946: 2007, the type of mechanical fixing used to fix the timber batten to the blockwork substrate through the insulant and the breathable membrane, may change the thickness of insulation required. These calculations assume the use of stainless steel fasteners of cross–sectional area 7.44 mm² at a density of 4.4 per m².*

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)			
	0.18		0.16	
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	Insulation Thickness (mm)	Overall Thickness (mm)
Kingspan OPTIM-R™ Rainscreen System*	50 + 50	100	60 + 60	120
Kingspan **Kool**therm®	80 + 80	160	90 + 100	190
Rock Fibre**	130 + 140	270	160 + 160	320

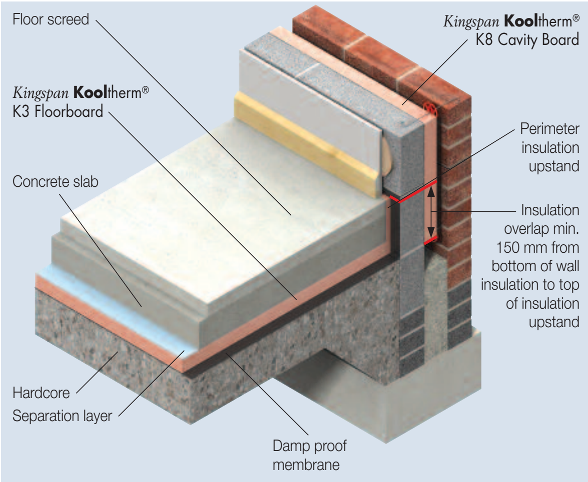
THINNEST
THINNER
THICKER

**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. These calculations assume that the Kingspan OPTIM-R™ component of the Kingspan OPTIM-R™ **Rainscreen System** *is adhesive–fixed to the substrate, and that all other insulation boards (including the Kingspan OPTIM-R™ fix component of the Kingspan OPTIM-R™* **External Wall System***) are mechanically fixed. When calculating U–values to BS EN ISO 6946: 2007, the type of discrete 'helping hand' bracket and insulation fixings may change the thickness of insulation required. These calculations assume carbon steel fixings of cross–sectional area 16.98 mm², with 3.13 fixings per m² and that the helping 'helping hand' brackets are installed at 600 mm centres both horizontally and vertically.*

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 Slab



Insulation Thicknesses to Achieve Different U–values					
	U–value (W/m²·K)				
	0.13		0.11		
Insulation Material	Insulation Thickness (mm)	Overall Thickness (mm)	Insulation Thickness (mm)	Overall Thickness (mm)	
Kingspan OPTIM-R™ Flooring System*	55	55	70	70	THINNEST
Kingspan **Kool**therm®	125	125	140	140	THINNER
EPS**	225	225	265	265	THICKER

**The bridging effect of the Kingspan OPTIM-R™ flex component 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.

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