warm|shell
Internal

Interior Wall Insulation
Design Guide

Publication date: 07/2023

Lime Green's Warmshell Internal is an internal wall insulation solution designed to radically improve the thermal performance of existing solid masonry buildings while ensuring moisture is controlled at safe levels within walls.

This moisture control is essential and ensures that the structural integrity of the building is maintained, and the health of the occupants are not compromised. Additional benefits of Warmshell Internal include improved internal acoustics, very low VOCs which help, along with the antiseptic properties of lime, to maintain good air quality. With the absence of biocides and toxic chemicals Warmshell Internal is safer to produce and use.

Furthermore, the woodfibre insulation employed at the core of the system sequesters carbon resulting in a much lower GWP (global warming potential) than the fossil fuel-based alternatives. https://www.materialepyramiden.dk/

Contents:

1 Introduction to Warmshell Internal

Warmshell Internal comes with a 25- year product warranty against material manufacturing defects, as outlined in our Warmshell Internal Warranty Terms document. See guide◢

As with any product or system designed for the retrofit of existing buildings it is key that support is provided throughout. Lime Green provide information and guidance that cover the Assessment, Design, and Installation of, Warmshell Internal.

This Guidance is designed to run alongside the other support documents for Lime Green's Warmshell Internal which include the following;

Assessment

- Site Assessment Checklist and Guidance. See guide◢

Design

- Design Guide
- Generic Design Details. See guide◢
- Specification Clauses. See guide◢

Installation

- Installation Guide. See guide◢

2 Drivers:

Over 27% of the UK's carbon dioxide emissions come from the residential sector, a figure so large that, if left unaddressed, the UK will not succeed in meeting its 2050 carbon emissions target. It is impossible to meet the 2050 target by simply de-carbonising the grid, as renewables are unable to replace all fossil fuel based power generation due to the energy concentrations that fossil fuels contain. Because of this the most effective way to achieve the 2050 target is by reducing the amount of energy needed. Up to 60% of all energy used in people's homes is for space heating, so when we recognise that approximately 85% of the UK's current building stock will still be standing in 2050, a reduction in space heating energy loads of the existing building stock is essential.

Currently, over a third of the UK's housing stock is of solid wall construction with walls accounting for the greatest area of heat loss in a house. For the vast majority of homes fitting Warmshell Internal is a key component to any energy efficiency measure for solid wall buildings.

3 Regulations:

Summary:

Regulations that directly relate to internal wall insulation, are mainly covered by three areas.

- Thermal performance - Approved Document Part L AD L1B
- Moisture Control - BS 5250 (moisture in buildings)
- Fire - Approved Document Part B in accordance with EN 13501-1:2007.

3.1 Regulations: Thermal Performance

The requirements for thermal performance of retrofitted properties are found in Approved Document Part L1B. Section 3.6, 3.8 and 9 of the Building Regulations. Current regulations give flexibility on u-value targets for buildings which have "permeable fabric that both absorbs and readily allows the evaporation of moisture" (Section 3.8 AD L1b) and as such should be given "special considerations".

This definition includes solid masonry and so is applicable to all solid wall buildings. Where special considerations apply, the aim should still be to improve energy-efficiency as far as is reasonably practicable. The target u-value should be defined by what is appropriate for the building and its context (including exposure and local weather, with a hygrothermal moisture risk calculation).

As such the back stop u-value in Part L1B is set at 0.7 W/m2K, which is significantly more relaxed than the minimum u-value for new build. In summary 'special consideration' applies to IWI on solid walls where "the risk of long-term deterioration of the building fabric, or fittings" is recognised (ADL1b, 3.9). "Technical, functional or economic reasons" are also a basis for flexibility on u-value target. (AD L1B, 5.12).

3.2 Regulations: Moisture Control

Correct moisture management is highlighted in Part L Building Regulations which, in turn, references BS 5250 (moisture in buildings). BS 5250 sets out the design guidance that should be followed when specifying any internal wall insulation. It is worth noting that to comply with the revision of BS 5250, Hygrothermal modelling tools that conform to BS 15026, such as WUFI Pro., should be used.

Modelling that complies with the older BS 13788, often referred to as the standard dew point calculation, or Glaser method, should not be used, as it is no longer compliant with the latest version of BS 5250 (Moisture in buildings). This is because, to quote **BS 5250**, "the methodology behind BS 13788 wrongly assumes built-in water has dried out and furthermore it does not take account of a number of important physical phenomena including hygrothermal assessment".

To quote from BSI's (The British Standards Institution) own website: "This revision of BS 5250 comes at a time when buildings are under increasing stress from moisture for two complementary reasons":

- The effects of climate change will impact directly on buildings because of increased penetration of driving rain, more frequent, deeper and longer lasting flooding and increased atmospheric humidity that slows drying rates.

- Energy conservation measures to combat climate change include reduction in ventilation, which increases internal humidity, and increased levels of thermal insulation, which makes the outer layers of the fabric colder. Energy saving retrofit of traditional buildings, which have been in equilibrium with the ambient climate for many years, can lead to significant moisture problems in the structure.

It is these two challenges; an increase in moisture load on the building fabric due to climate change and the necessity to apply insulation, to reduce energy use and combat climate change. This is exactly what Warmshell Internal is designed to address. Importantly Warmshell Internal also ensures that the moisture equilibrium of the building fabric is not compromised.

i.e. an increase in moisture load on building fabric, due to climate change, a need to significantly improve the thermal performance of existing buildings, whilst ensuing moisture equilibrium of the building fabric is maintained.

3.3 Regulations: Fire

Current fire regulations are set out in Approved Document Part B (fire safety) of buildings regulations. Any internal wall insulation system must comply with EN 13501-1:2007+A1:2009 for buildings up to 18 meters in height in England and Wales and 11 meters height in Scotland. Warmshell Internal is a composite insulation system with a thick plaster finish and has been successfully tested to give a fire classification: B-s1, d0 under with EN 13501-1:2007+A1:2009.

4 Why Warmshell Internal?

Summary:

- Significantly reduces heat loss by 70% with just 50mm of insulation and plaster on a solid Victorian brick wall.
- Buffers heat increased comfort levels
- Overcomes restrictions with external wall insulation
- Can be installed irrespective of bad weather
- Lime based, the internal surface has antiseptic properties of lime, helping to maintain good air quality through the absence of biocides and toxic chemicals.

Aside from the reduction in CO_2 emissions and energy associated costs, there are a number of additional benefits from installing Lime Green's Warmshell Internal. These include:

- The thermal mass of Warmshell Internal 'buffers' heat more effectively than lightweight synthetic insulation, providing better levels of thermal comfort through a more steady state room temperature. Warmshell Internal increases internal wall surface temperatures which further contributes to improved comfort levels and the elimination of surface condensation that leads to mould.

- Just 40mm of Warmshell insulation (the thinnest Warmshell Insulation board), fitted to a solid brick Victorian wall will reduce the heat loss from that wall by approximately 70%. This is clearly a very large reduction in heat loss, but with a u-value of approximately 0.6W/m2K (which is in fact compliant with Part L1B) it is often not recognised as such. This is due to the lack of understanding about heat loss and u-values calculations.
  To illustrate this, if the thickness of insulation is increased to meet the minimum new build u-value of 0.3W/m2K the reduction in heat loss, against the original Victorian wall, would now be approximately 87%. This is only a small increase over the 70% reduction with a u-value of 0.6W/m2K. Whilst the targeting of a low u-value should always play a key part in the specification process, it is important to know the actual heat loss proportions, especially as any internal wall insulation solution should also be carefully weighed against risk and benefit.

- External wall insulation solutions, such as **Warmshell External** (See guide◢) provide an uninterrupted thermal jacket around the building. While external insulation is often seen as the most effective generic solution to a solid wall, there are a number of significant parameters that can prevent this. These include; access issues to the exterior walls; buildings in conservation areas, or where the aesthetic of the building exterior needs to be retained; excessive rainwater goods, soil pipes etc.; complex building geometry, such as bay windows and so on. Internal wall insulation allows for a phased insulation rollout, which can be less disruptive to the household and can follow a redecoration program.

- Warmshell Internal can be installed all year round*, as it is not affected by the weather and eliminates the need for scaffolding.
  *on the understanding that the exterior of the property is fit for purpose; see site assessment guidance on Page 7. (See guide◢)

- Airtightness is key to a building's thermal performance. Airtightness solutions are best installed to the inside of a property as they are simpler to install and test. Warmshell Internal delivers significantly improved airtightness, which is more challenging to deliver through external insulation solutions.

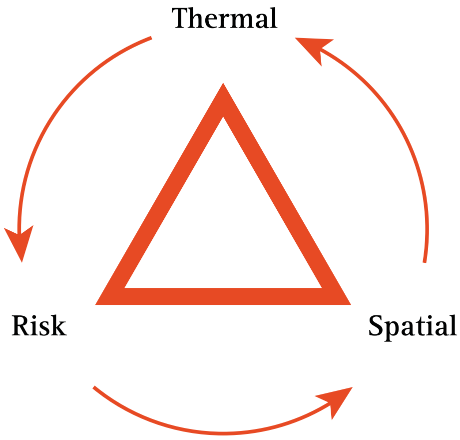
5 General Design Principles

Summary:

- The u-value must be carefully considered against the y-values (thermal bridging), to avoid specifying ineffective and unnecessary additional thicknesses of insulation.
- Thermal bridging should be reduced as much as possible. Hard to treat areas, such as window reveals, must have a minimum level of insulation.
- Ensure good airtightness by providing one continuous, uninterrupted airtightness layer, through the carful installation of integrated plasters, tapes and membranes.
- Target the lowest u-value possible while ensuring both risk and spatial impact have been fully considered. There is a significant probability of failure if thermal performance is the only consideration. As a result a target u-value for internal wall insulation better than 0.35 W/m2K is rarely appropriate.

Three Primary considerations are required when specifying any internal wall insulation solution;

1. A target thermal performance
2. A clear understanding of the potential risks that could occur as a direct result applying IWI
3. An understanding of the spatial impact on the property, both physical and aesthetic



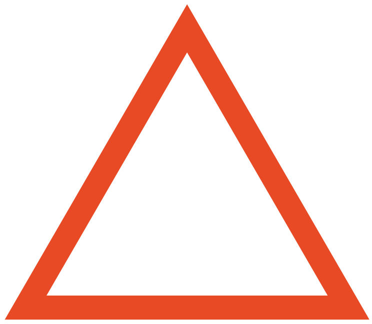
Each of these three areas impacts the other. As such it is often ineffective to simply consider each area sequentially and in isolation, but rather review each one in turn considering the impact it may have on the other two.

5.1 Thermal Performance

When deciding the thermal performance required of Warmshell Internal the process will almost always be led by a building assessment such as Rd SAP (reduced SAP), SAP , or PHPP, the latter being the most accurate. This will provide an initial target u-value for the Warmshell Internal on the building. This target u-value will define the thickness of insulation, which in turn will affect the risk levels and spatial impact. Once risk levels and spatial impact are considered, a revision of the initial target u-value and resulting insulation thickness may be required.

There are three primary areas to consider when the thermal performance of a building. These are as follows:

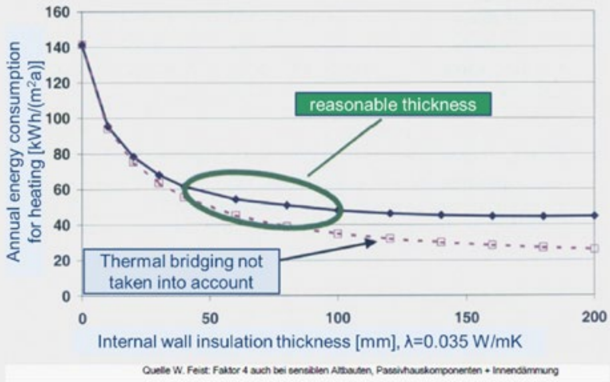
1. The main elements of the building envelope (u-values), such as roof, walls, windows, floor.



2. The junctions between the main building elements (y-values thermal bridging)
3. Airtightness

	40mm Warmshell Woodfibre + Solo	60mm Warmshell Woodfibre + Solo	80mm Warmshell Woodfibre + Solo	100mm Warmshell Woodfibre + Solo
Wall Type	U Value W / m²K			
215mm brick wall	0.68	0.52	0.39	0.32
330mm brick wall	0.61	0.48	0.37	0.31
500mm Limestone wall	0.63	0.49	0.37	0.31

1. When applying insulation to the main elements of a building, such as the wall, it is important to understand energy efficiency that the increase in thermal performance is not linear. As the insulation thickness increases the scale of the gain decreases. This can be seen clearly by the lower dashed line in the graph 2.0 below. For every additional millimetre of insulation (horizontal axis) the reduction in heat loss (the vertical axis) is less than the previous millimetre of insulation. Graph 2.0 also includes an unbroken blue line. This shows the significant impact that thermal bridging has, (where thinner thicknesses of insulation have been necessary due to details such as window revels) on the effectiveness of greater thicknesses of insulation.



Graph 2.0

2. The junction between insulated wall. This is the case when insulating any building, but it is effectively exaggerated with internal wall insulation due to the number of thermal bridges present, such as window/door reveals, joist ends etc. It is not only the number of but also because many of these, in particular window and door reveals, can only accommodate relatively small amounts of insulation when compared to the main element of the wall. As you can see in graph 2.0, this results in even fewer gains being made through an increase in insulation thickness. This is important to understand as it shows that the pursuit of low u-values, through internal wall insulation is in most cases futile and that a u-value of 0.35 – 0.4 with good detailing will give you significant improvements to the wall's overall performance (upwards of 82%), whilst still complying with building regulations.

Thermal bridging needs to be kept as low as is practically possible as it can account for as much as a third of the heat lost from a building. It is also an area of risk which, if not properly considered, can lead to surface condensation and other moisture related problems. Almost all potential thermal bridges and details will require some level of insulation.

All principal details are covered in the following Generic Design Details. (See guide◢)

- Window Reveal Details
  - Existing window IWI 002a
  - Existing window + secondary glazing wall IWI 002b
- Standard Floor Details
  - Intermediate floor [At 90° to Joists] IWI 003a
  - Intermediate floor [Parallel to Joists] IWI 003b
  - When access is available from below the floor IWI 003c
  - When access is available from above the floor IWI 003d
- Roof
  - Eaves detail cold roof IWI 004a
- Additional Useful Details
  - Junction with internal solid wall (A) IWI 005a

- Junction with internal solid wall (B) IWI 005b
- Junction with new internal wall, timber IWI 005c
- Wall below external ground level IWI 005d
- Integration of services IWI 005e

Further notes on each of these details can be found in the second half of this Design Guide under **6.0 Design Details.**

3. Airtightness is just as key to energy efficiency as insulation, so when specifying the thermal performance of a property it is prudent to assess and reduce air leakage.

   Airtightness should be delivered as one continuous, uninterrupted layer across principal areas, such as the wall, roof and floor and the interfaces between these principal areas and elements. These include window frames, door frames and wall penetrations like soil pipes and joist ends. For Warmshell Internal, the layer of airtightness can be placed at the back of the Warmshell insulation with airtightness made up from the existing plaster (assuming it is in sound condition) or the Duro parge coat, with tapes between this and the window frames, door frames or wall penetrations. Alternatively can be specified at the front of the system, provided by the 2 passes of Solo internal plaster, which again needs to be sealed to the relative interfaces between plaster and door frames, window frames, wall penetrations etc., using suitable tapes.

   Partial penetrations such as Joist ends must also be considered as these can lead to air movement to the outside. In relation to joist ends, as well as some other building details, it is important to note that there is a secondary role to airtightness, which is to reduce the risk caused by air tracking down the side of the joist.

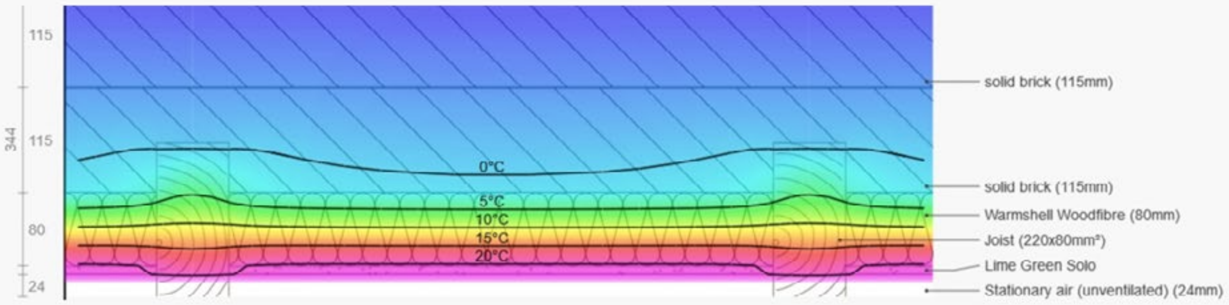


Image 3.0

Image 3.0 clearly shows the temperature against the colour band. The joists can be clearly seen penetrating through the insulation zone into the wall. Once Warmshell Internal is fitted, the main wall area is colder and as a result condensation is more likely to occur at the end of the joist as warm air, from inside the building, tracks through the wall. When the warm air cools to the point that it reaches 100% relative humidity liquid moisture is formed*. Wall penetrating materials, such as joist ends, are particularly vulnerable and should therefore be either taped, or dubbed in with lime plaster to ensure there is no gap between the wall and the penetrating joist; see detail IWI 003a/b in Design details.

*a full explanation on moisture dynamics can be found in the section on Risk, below.

5.2 Risks

Summary:

- Moisture presents a significant risk if it has not been correctly accounted for. It must be taken into full consideration when specifying internal wall insulation.
- Dewpoint calculation for internal wall insulation, based on BS 13788 are no longer valid, as stated in the revised BS 5250. Assessment in accordance with BS 15026 is now required using software such as WUFI Pro. Warmshell Internal has been assessed using WUFI Pro. It is suitable across the full range of thicknesses in exposure zones 1 and 2, without further assessment. If the specification is for 80mm or 100mm of insulation in Exposure Zone 3, or for any amount of insulation in exposure zone 4, a further WUFI Pro. assessment is required.
- If the property has impervious external render a WUFI assessment is required, irrespective of the exposure zone.
- Most monolithic solid wall properties were designed to let moisture dry out to both the inside and the outside, Warmshell internal maintains this dynamic.
- Warmshell Internal, in accordance with EN 13501-1:2007, has a very good fire rating and is suitable on all buildings below 18 meters in England and Wales, and below 11 meters in Scotland.

	40mm Warmshell Woodfibre + Solo	60mm Warmshell Woodfibre + Solo	80mm Warmshell Woodfibre + Solo	100mm Warmshell Woodfibre + Solo
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500mm Limestone wall	0.63	0.49	0.37	0.31

The above desktop calculations compare with in situ monitoring undertaken by the SPAB and research by the BRE

Possible risk of condensation in wind driven rain areas exposure Zone 3. Hygrothermal assessment according to BS 5750, such as a WUFI Pro. Calculation is recommended.

Possible risk of condensation in wind driven rain areas exposure Zone 4. Hygrothermal assessment according to BS 5750, such as a WUFI Pro. Calculation is recommended.

There are a number of risks associated with the installation of internal wall insulation, but arguably the two most significant risks are those posed by moisture and fire.

5.2i Moisture

One of the greatest risks in fitting insulation to the internal wall of a building is related to moisture. Moisture in buildings is found as either a liquid or as a gas (water vapour). Moisture and the way it behaves in building space and building fabric is a complex subject, but the following information should outline the key areas that can help with principal design. This will also help identify areas where specialist support, or calculations, are required.

It is important to understand that when insulation is fitted to any building the inherent physics of the fabric is changed. If this is not appreciated and the methodologies that lie behind Warmshell Internal are not implemented correctly, then there is a very real risk that the building fabric could be compromised, or more seriously the health of the occupants could be harmed. One of the main risks from these 'changes in building physics' comes from the way moisture moves in the building fabric, a dynamic that must be managed correctly.

From the start of any Warmshell Internal specification, moisture sources and their effect on the building, both internally and externally, should be carefully considered. This can be achieved by understanding how moisture behaves, as both a liquid and a gas, within a building.

Moisture as a gas (moisture vapour). The percentage of moisture in the air has a big impact on human health and comfort and on the long-term integrity of the building fabric.

Figure 4.0 shows the remarkable correlation between human health, human comfort and relative humidity. As shown, the 'optimum zone' of human comfort coincides with an area on the scale of relative humidity (horizontal axes), where those listed to the left of the table find it next to imposable to proliferate.

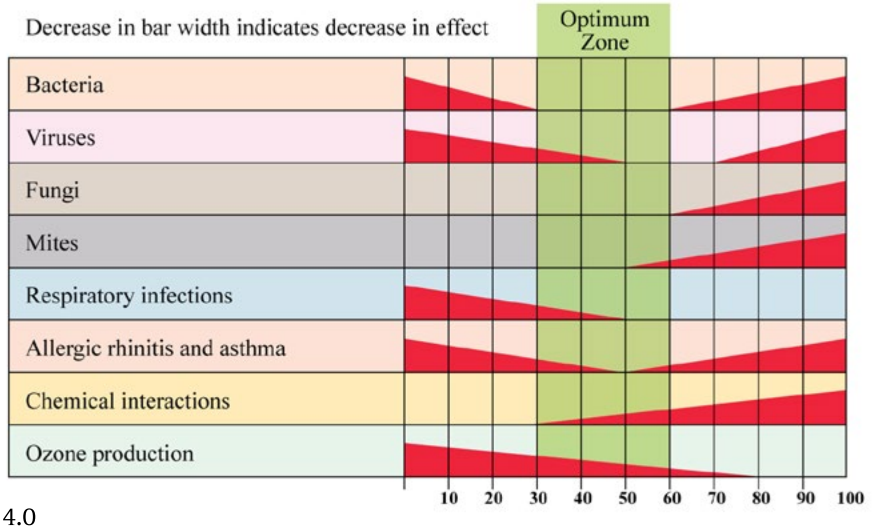


Fig 4.0

The space within a building, which therefore needs appropriate ventilation and also the fabric of the building. Both of which have a significant impact on the occupants. By understanding relative humidity, we have a greater insight into how best to specify insulation.

The percentage of moisture in air the varies due to two things; how much moisture is being released into the air from different sources, and the temperature of the air. Moisture sources within a building come from numerous areas, as shown in the table 3.0 below.

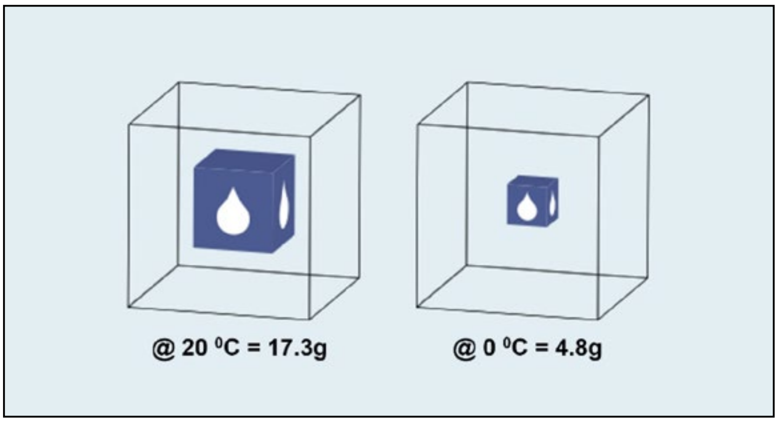
Activity	Litres moisture per day
A family asleep	1.5 - 2.0
Typical daytime activities	2.5 - 3.5
Cooking	2.0 - 3.5
Washing and bathing	1.0 - 1.5
Washing clothes	0.4 - 0.6
Drying clothes	3.0 - 5.0
Approx. Total	9 - 15 ltrs.

The figure of 9 - 15 litres is the quantity of moisture that is absorbed by the air during a 24hr day for an average UK household. This is a lot of moisture and it has to go somewhere. The majority of it will be lost through air leakage out of the building (which is why the more airtight you make the building the more deliberate you should be about the ventilation).

Air holds moisture, like a sponge and the amount of moisture it can hold is relative to its temperature. For example, warm air at 20°C, holds a maximum of only 17.3 grams of moisture per m3, whereas air at 0°C holds only 4.3g. The term 'Relative Humidity' RH is used, as the moisture content of the air, measured as a percentage, is relative to the temperature, for example:

Air Temp = 20°C moisture content @ 50% = 8.7g [max moister content = 17.3g]

Air Temp = 0°C moisture content @ 50% = 2.2g [max moister content = 4.3g]



So, as air changes temperature, the RH percentage increases (as the air cools) or decreases (air warms) even though there is no additional moisture in absolute terms. By example, if air with an RH of say 50% at 20°C is cooled you will see the RH go up, until the temperature reaches 9°C at which point the Relative Humidity will have reached 100%. At this point moisture vapour will turn into liquid moisture and will start to fall (or condense) out of the air. It is this dynamic that plays a significant role in the application of internal insulation within a building, as by incorporating insulation you are cooling the outer fabric of the building.

When insulation is fitted internally to a wall, the day-to-day temperature of the external wall decreases compared to the wall temperature before the insulation was fitted. This is because the heat load warming the wall has been reduced by the insulation. The more insulation that is applied internally, the colder the wall. The colder the wall, the more likely the moisture vapour in the air moving through the wall* will reach100% RH, at which point the moisture falls out of the air liquid within the wall. This is known as interstitial condensation and used to be assessed by a condensation risk assessment (sometimes known as a dewpoint calculation) to BS 13788. This standard is no longer suitable as stated in the latest revision of BS 5250, see previous 2.2 Regulation Moisture Control.

*heat energy will try and find its own level, a bit like water. This is why a house in the winter cools down, as lower volumes of high heat energy inside a building flow to higher volumes of low heat energy outside. As the heat energy moves through the walls it takes moisture vapour with it. Insulation slows down this movement of heat but has a dynamic effect on the temperature of the wall and thus the relative humidity of the wall.

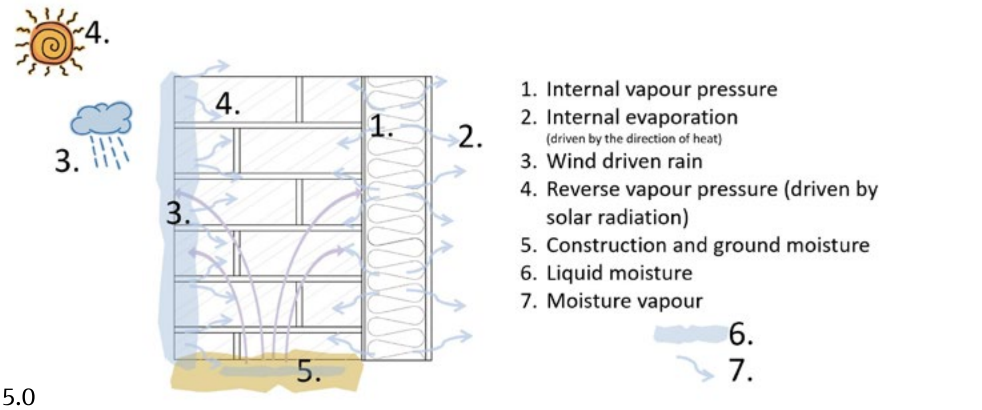


Fig 5.0

In addition to understanding moisture inside the building and its movement from the inside to the outside, we also need to consider the effects of external moisture acting on the building. Moisture is accumulated in porous brick, or stonework, following rain. This accumulated moisture evaporates when the sun comes out, but not all of it. A significant amount of moisture is also driven into the fabric, where, due to the porosity and vapour openness of the fabric, it will dry out. It is therefore important that any internal wall insulation solution applied to an existing building must take account of these two dynamics and allow the wall to continue to dry out in both directions, to the inside and to the outside. This can be clearly seen in fig. 5.0 and is the reason BS 5250 was changed to include hygrothermal assessment based on BS 15026, as the previously used dew point calculations, based on BS 13788, do not take account of a number of important physical phenomena including moisture drying to the inside, liquid moisture etc. It is also important to note that hygrothermal assessments include a more comprehensive set of weather data to that found in BS 13788.

The Warmshell Internal system has been assessed and is suitable for all thicknesses from 40mm through to a maximum of 100mm, for exposure zones 1 and 2. (See exposure zone map 6.0). For thicknesses of 80mm and 100mm, in exposure zone 3 and for any thickness in exposure zone 4 it is recommended that a hygrothermal assessment according to BS 15026, such as WUFI pro., is made. These define the safe operational parameters of the system.

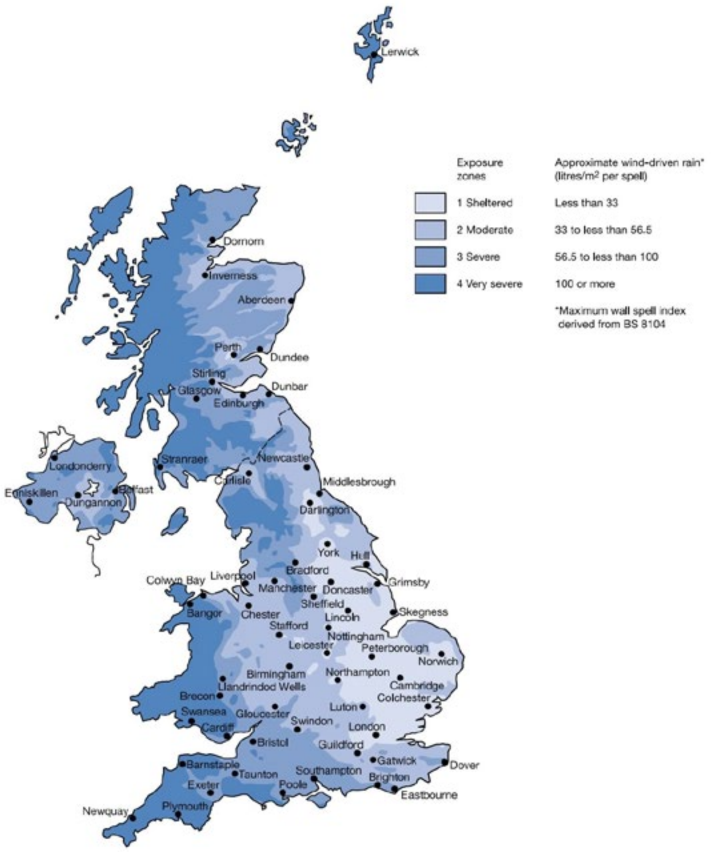


Fig 6.0

Warmshell Internal has been specifically designed to dry out to both the inside and the outside, allowing moisture to be regulated at safe levels within the fabric. This is achieved through several key properties and mechanisms, within the system, these which include;

- Vapour openness – allowing moisture vapour diffusion through the wall – moisture moving as a gas.
- Hygroscopicity – high absorption and temporary storage of moisture as both a vapour and liquid, which prevents moisture build up at a single point, such as the interface between the existing wall and insulation and so prevents the accumulation of liquid condensation (interstitial condensation).
- Capillarity – provides liquid moisture redistribution.

5.2ii Fire

Clearly any material addition to a building must comply within relevant fire safety standards. Lime Green takes its fire protection responsibilities seriously and has worked hard to ensure that Warmshell Internal meets, or exceeds, regulatory requirements. As covered in the earlier section on 3.3 Regulations Fire, Warmshell Internal, in accordance with EN 13501-1:2007, has a fire classification: B-s1, d0. (See guide◢)

It is important to note that Warmshell Internal makes a significant contribution to fire resistance. Warmshell Insulation has a much higher thermal mass than other synthetic solutions, over five times as much. This almost completely prevents heat penetration, helping to buffer heat during the early stages of a fire and significantly increasing the time it takes for a fire to take hold. This provides extended evacuation time and increases the time available for the fire services to reach the property to tackle the fire.

5.3 Spatial impact

The spatial impact on the property, both physical and aesthetic, must also be considered against the Thermal Performance and Risk when designing an IWI upgrade. Keeping original features such as coving can cause thermal bridging, leading to condensation and mould, so it may be better to reinstate such a feature. Alternatively, a lack of regard for spatial impact can lead to poor specification, despite providing optimum thermal performance and low risk, resulting in a solution that may seriously affect the aesthetics of a building, or impede the available space on a practical level.

Older building design often incorporated levels of knowledge and understanding that improved the health and well-being of the occupants, such as high ceilings large amounts of natural light etc. which are often compromised in modern housing design due to the pursuit of reducing costs. It is important to ensure that improvements to the energy performance of buildings, such as IWI, do not also compromise these well design original features.

6 Design Details

The following section of the Design Guidance should be used alongside.

Older and historic, properties can have a plethora of unique details, so while it is imposable to cover all eventualities the second half of this guide will provide a principal approach to most of the key details.

The first stage of the specification must ensure all remedial works, including services, to the building have been identified and the appropriate works specified. Preparation is key to the specification of Warmshell Internal. The building must be dry and in a good state of repair water goods such as guttering, down pipes etc. must also be in sound condition. Brick, stone and rendered surfaces should be sound and mortar joints in good repair.

The Lime Green Site Assessment Checklist and Guidance (See guide◢)
Should be used BEFORE Warmshell Internal is installed.

6.1 Standard wall build up IWI 001a

The Warmshell woodfibre insulation must be fully bonded to the wall. THERE MUST BE NO GAPS between the insulation and the wall, as gaps create the best conditions for mould, that is: cold, higher levels of moisture, due to reduced capillarity and a supply of oxygen. The wall must be dry and level (+/- 4mm over 1.5meters).

As per Site Assessment Guidance 3. Existing Internal Lining (See guide◢) Unless the existing internal lining is a lime-based plaster and in sound condition all existing materials should be removed (N.B. carful assessment should be made of the surface finish of lime plaster, any impermeable material such as oil-based paint should be removed, any semi-permeable material such as emulsion should be scratched or scarified, as per Specification Clauses 8.2 (See guide◢). All wallpaper should be removed. Walls should be made good, deep voids should be filled and if required a parge coat, or dubbing out coat, of Lime Green Duro, should be applied to the whole area, +/- 4mm (over 1.5-meter distance).

Ensure all electrical services that are to remain on the inside face of the external wall are accounted for and either chased into the existing wall, dubbing in with Duro (See product◢), or chased into the surface of the Warmshell insulation after fitting, (see below IWI 005e).

The woodfibre Warmshell Insulation is bonded to the wall using Warmshell Board Adhesive. This not only creates a bond between the insulation and the wall, but also enables moisture to move unhindered between the original wall and the new insulation system. This allows the moisture to be regulated at safe levels and enabling the wall to dry out. Furthermore, the board adhesive is lime based, which is alkaline. Mould does not establish itself easily in an alkaline environment.
If the wall has a bow, or curve that is too great to level out, but is preventing a Warmshell insulation board from bonding fully to the wall surface, then a thermally broken fixing, such as Ejot H1 Eco should be used to hold the board tight against the wall, again to remove air gaps.

Once the board is in place allow the Warmshell Adhesive to cure overnight.

Once the boards are fully bonded, as previously, ensure all electrical services, that are to remain, are chased into the surface of the Warmshell insulation, running within conduit and dubbing in with Solo plaster (See product◢). (see below IWI 005e).

The internal plaster, Solo, is applied in two passes directly onto the Warmshell Insulation. The first pass of Solo plaster, approximately 4mm in depth, is applied to the Warmshell insulation, then the surface is fully meshed. Mesh to be overlapped by 100mm. Additional mesh, or meshed beading is to be used, to reduce the risk of cracking, along all exposed board edges and around all openings, such as window reveals. Bed the mesh in the first pass and then apply the main mesh overlapping with the edge strips by a minimum of 100mm. The mesh helps to firm up the surface, this allows a second 4-5mm pass of Solo plaster to be made over the first. As a result, the mesh is now within the centre of the full Solo build up. Curing time is 1mm/day.

6.2 Generic Design Details (See guide◢)

6.21 External Corner IWI 001b

6.22 Internal Corner IWI 001c

External and internal corners of the insulation board need to be fitted tightly where they join. Meshed bead, or additional mesh is recommended on an external corner. It may also be helpful to use thermally broken fixings, such as Ejot H1 Eco to hold the boards tight against the wall, as an additional measure if required.

6.23 Existing Window IWI 002a

Window detail is critical to the final overall performance of the property once works are complete. Two areas to be kept at the forefront of the design process are;

- Thermal bridging
- Airtightness

As outlined previously, thermal bridging needs to be kept as low as is practically possible, but it also ensures that there is a minimal risk of mound growth. When the wall meets a window opening, insulation must return into the window reveal from the main wall. The insulation thickness will, most likely need to be reduced as the limiting factor controlling the depth of the insulation is the window frame. This can be either a reduced thickness of Warmshell Insulation, which can if necessary be cut down in situ, or a more specialised insulation such as Aerogel.

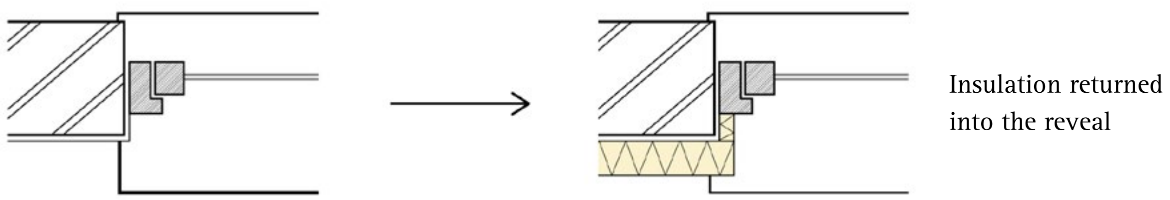


Image 7.0

The risks associated with uninsulated reveals, sills and window heads cannot be overstated. As mentioned previously, once fitted with internal insulation the wall becomes colder. This in turn means reveal, sill, or window heads become colder, which reduces the temperature of the air immediately adjacent to them. This increases the RH percentage, quite often to 100%, leading to moisture falling out of the air creating condensation against the wall. Black mould will only grow when clean water is present, a clear 'marker' for cold spots.

If the window frame is flush with the internal wall, or can be moved to a flush position, a much simpler detail has been created as seen in 8.0

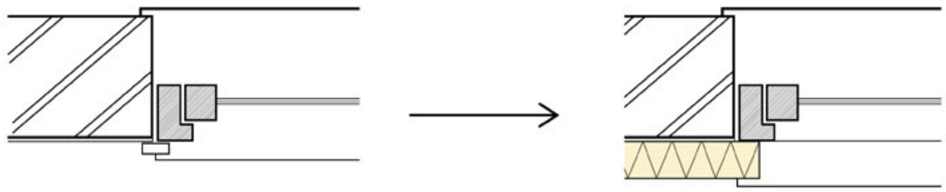


Image 8.0

The same thermal bridging detailing also needs to be considered for a doorframe.

6.24 Intermediate Floor at 90 Degrees to Joists IWI 003a

An area that is often overlooked is the intermediate floor between the ceiling and the floorboards of the floor above. This makes up a narrow section of the external wall that needs to be insulated. If this area is excluded there will be a significant amount of heat loss, undermining the performance of the walls that have been.

Once insulation is installed, the wall is colder than before the installation, as mentioned a number of times already in this guide. Air passing down the side of a timber joist will cool, and this will potentially lead to liquid moisture falling out of the air as the cooling air reaches dew point. This in turn can result in an accumulation of liquid moisture resulting in potential rot at the end of the timber. To avoid this, the gap between wall and joist must be taped, or dubbed in with lime plaster such as Solo, or Duro. To provide ample access to the intermediate floor zone, simply cut the floorboards back to the depth of the insulation, plus 10mm (for plaster and Warmshell board adhesive). Once the joist ends have been dealt with, flex woodfibre insulation can be fitted tightly between the joists and against the wall.

6.25 Intermediate Floor, parallel to Joists IWI 003b

When the joist is running parallel to the external wall, continue the dubbing out of the main wall as far as possible, to help airtightness. Fill the void tightly with flex woodfibre insulation.

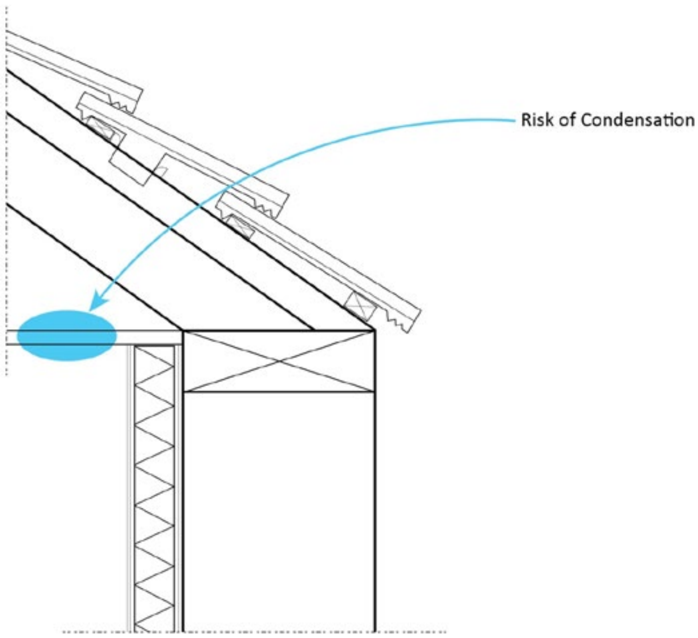
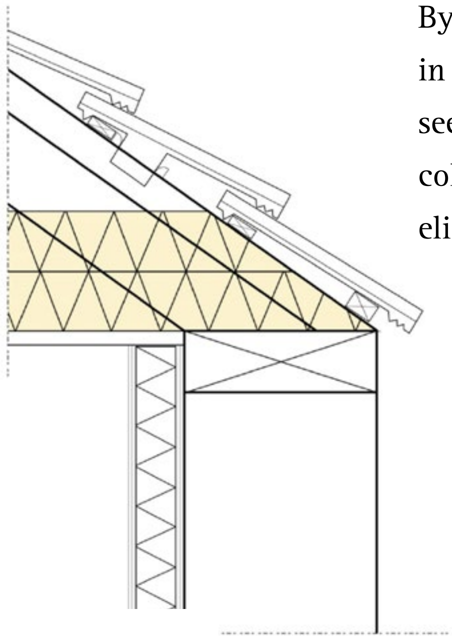


Image 9.0

6.26 Eaves detail cold roof IWI 004a

As the Warmshell Internal is specified every effort should be made to ensure there are no cold bridges, as outlined in 6.23 on window detailing. Another area where additional care should be made is the interface between the wall and the ceiling adjacent to a cold roof space.



By ensuring continuity in the insulation, see image 10.0 any cold bridging will be eliminated.

Image 10.0

6.27 Junction with internal solid wall (A) IWI 005a

6.28 Junction with internal solid wall (B) IWI 005b

Care should be taken at the junction where an internal wall abuts an external wall that has been fitted with Warmshell Internal. If the insulation fitted to the outside wall is greater than 60mm there is a risk that condensation could occur on the return of the adjoining wall. It is important to install approximately 200mm length (i.e. not depth!) (See IWI 005b) of insulation on the return wall in order to eliminate the risk of cold spots and mould growth. To prevent a detail where the insulation 'steps out' into the room at the return, the plaster can be cut back and Ultra plaster (See product◢), or Aerogel insulation installed and finished flush with the existing return wall.

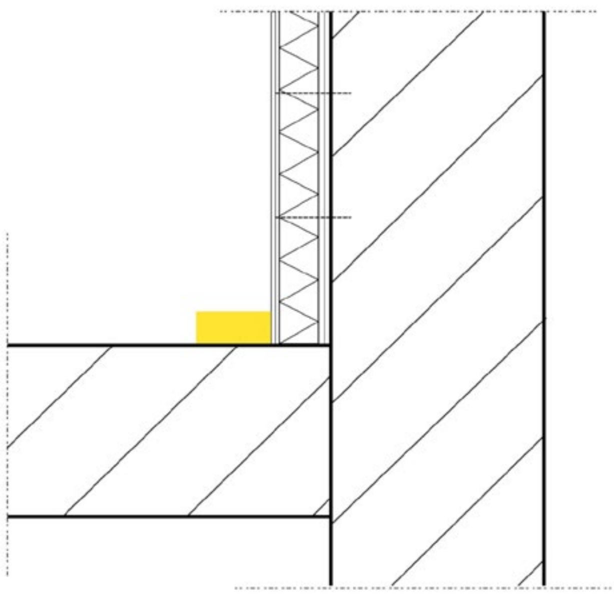


Image 11.0

6.210 Junction with internal solid wall (B) IWI 005e

When integrating services around Warmshell Internal start with assessing what services are found on the inside of the external walls, e.g. water, gas, electrical. Water and gas should be either be re-routed, or brought directly through the Warmshell Internal. It is better if electrical wiring is relocated onto the internal walls of the building, but if this is not possible then electrical services can be chased into either the existing masonry, or the front of the Warmshell insulation. In both cases the cable should be run in conduit then the conduit should be fully dubbed in with either Duro, or Solo plaster.

For water services, pipes etc., to be accessible, and for pipe runs to be as simple as possible, any water pipes either fresh, or waste-water, must run directly through, at 90° to the Warmshell Internal, if they cannot be relocated. Pipe runs, sandwiched between the internal face of the external wall and Warmshell Internal must be avoided. See figure 2.0.

This design guide is part of a series of materials designed to support the specification and installation of Warmshell Internal these include:

Assessment;

- Site Assessment Checklist & Guidance (See guide◢).

Design;

- Design Guide
- Generic Design Details (See guide◢).
- Specification Clauses (See guide◢).

Installation;

- Installation Guide (See guide◢).

Waiver of Liability;