Insulation

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Passivhaus Buildings: Case Studies

Kingspan®

*Low Energy –
Low Carbon Buildings*

Contents

What is Passivhaus?

Introduction

'Passivhaus' is a low energy construction standard. A Passivhaus building requires very little energy for heating or cooling, whilst providing a high level of comfort for the occupants. Passivhaus was developed in the 1990s by Dr Wolfgang Feist, who was concerned that buildings consumed much more energy when built than was predicted at the design stage. Attention to detail, rigorous design and construction and an exacting certification process ensure that what is designed is built, and what is built performs as it was designed. This is achieved primarily through a fabric first approach, meaning high levels of thermal insulation, high levels of airtightness and the use of whole house Mechanical Ventilation with Heat Recovery (MVHR).

The thermal insulation requirements of Passivhaus demand that roof, wall and floor U–values are equal to or less than 0.15 $W/m^2 \cdot K$. Kingspan Insulation offers amongst the thinnest commonly available insulation, meaning that space taken to achieve the stringent U–value is kept to a minimum. Over 65,000 buildings have been constructed in accordance with Passivhaus principles, with over 200 certified projects in the UK (June 2018). Kingspan Insulation has created this document to help architects, specifiers and contractors learn a little more about Passivhaus in practice.

10 Certified Passivhaus projects are examined here, covering both new build and refurbishment. Each of the projects uses high and premium performance Kingspan Insulation products as part of the build.

To promote the principles of Passivhaus as a highly effective way of reducing energy use and carbon emissions from buildings in the UK, Kingspan Insulation became one of the founding members of the Passivhaus Trust.

Passivhaus Trust FOUNDER

More information on Passivhaus can be found by visiting:
www.passivhaus.org.uk
www.passivhaustrust.org.uk
www.passipedia.com

Case Study 1: Grove Cottage

Project Name: Grove Cottage

Building Type: Retrofit
Location: Hereford
Status: Certified
Building Use: Private Residential
U–value Performance of Roof: 0.09 W/m²·K
U–value Performance of External Walls: 0.12 W/m²·K
U–value Performance of Ground Floor: 0.193 W/m²·K
Air Tightness: 0.82 m³/hr/m² at 50 Pa

Kingspan Products Used:
Kingspan **Kool**therm® K3 Floorboard
Building Owner, Architect & Developer:
Simmonds Mills Architects
Main Contractor: Eco–DC

Introduction

Grove Cottage was originally built in 1869 in open countryside, but over subsequent years properties were built on either side in close proximity to the cottage. This, together with the cottage's design, led to a few key challenges for the construction:

- a 25 mm gap between the gable wall of Grove Cottage and a neighbouring property acted as a thermal bypass, channelling the wind between the properties and removing heat from both; and
- as exterior insulation was used on the property, care needed to be taken with the new render in order to maintain details from the building's original exterior such as window sub–sills and stone lintels.

With retrofit projects it is accepted that it may sometimes be impossible to achieve the performance required of Passivhaus, either due to planning restrictions, cost, or the building's design. As a result, the EnerPHit status was created, setting slightly lower targets, while still ensuring a high level of performance. Grove Cottage was retrofitted to this level of performance.

The cottage's owners also used the retrofit process as an opportunity to extend the two bedroom property, providing an additional upstairs bedroom along with a new ground floor kitchen. The extension led to the additional challenge of finding ways of insulating the new concrete block and brickwork. As part of the retrofit, the premium performance of *Kingspan* **Kool**therm® K3 Floorboard was crucial in helping the property floors achieve EnerPHit status.

Technical Summary

Roof: U–value 0.09 W/m²·K

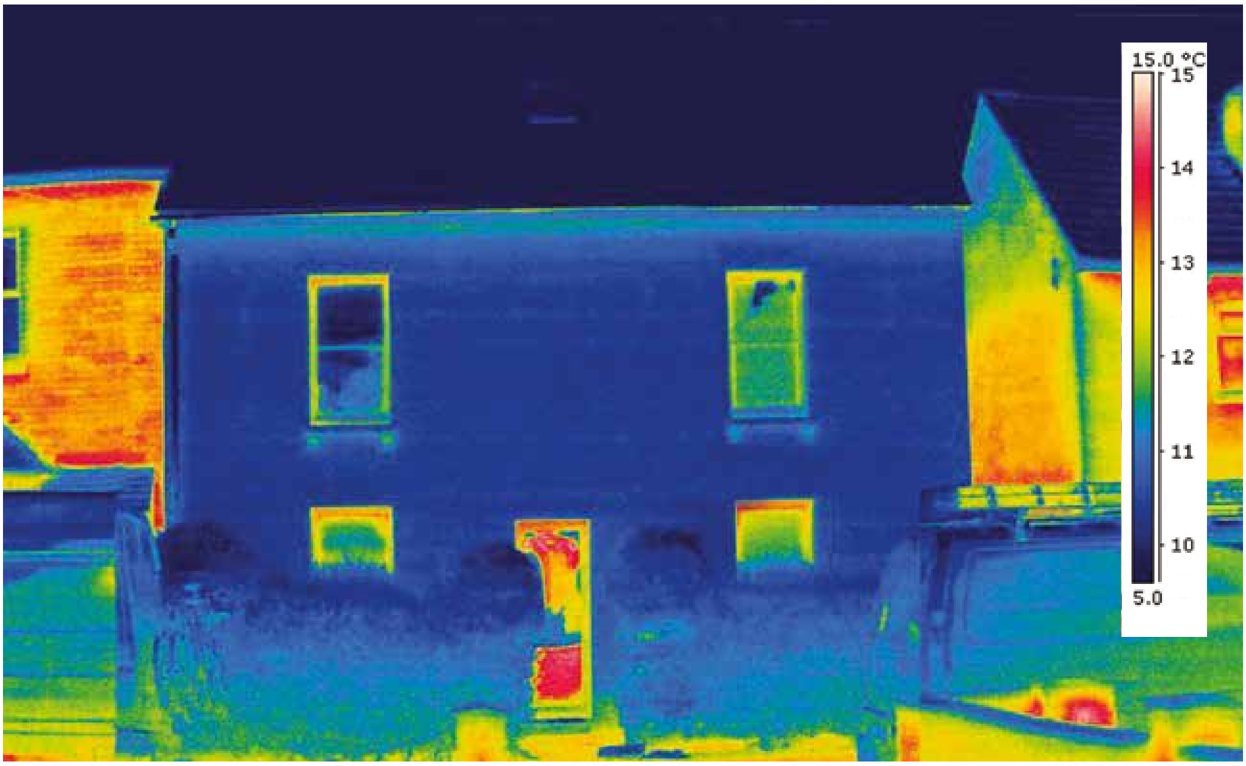
The original rafters within the property were turned into A–frames and boarded over. A polyethylene air–vapour barrier was then placed on the boarded surface, also helping to make the building weather–tight during the construction work. Timber I–beams and noggings were fitted on top of the original rafters, providing enough depth for 400 mm of mineral fibre insulation to be installed.

The roof of the new rear extension was specially built to be covered in green roofing

External Walls: U–value 0.12 W/m²·K

Two approaches were used to insulate and make the property's external walls airtight:

- the majority of existing brickwork and all concrete block work on the new extension were insulated using a 250 mm thick insulated render system adhesively bonded to the brickwork. The masonry paint on the brickwork meant that the render boards needed to be additionally secured using plastic fixings with a metal shaft running through them. The fixings were recessed into the insulation and 25 mm disks of polyurethane insulation were adhesively bonded over the fixings to minimise thermal bridging; and



Upgrading the fabric on the external wall has substantially improved the thermal performance

(Thermal Phototography courtesy of Daniel Bokker at Thermal Inspections Ltd.)

Careful detailing was an essential part of the building's success with tape used to ensure difficult junctions remained air–tight
(Image courtesy of Simmonds Mills Architects)

- all the original brickwork was covered in a cement based slurry to help make the walls air–tight, whilst at the rear of the property 350 mm site–built timber ladder trusses, filled with semi–rigid glass mineral wool slabs, were fitted to the old brick rear extension. The trusses were clad in timber board followed with a 12 mm OSB layer to help air–tight the extension.

Party Walls: U–value 0.39 W/m^2·K

The nearest neighbouring property to Grove Cottage was built within 25 – 40 mm of the gable wall of the property. The gap created a thermal bypass, with wind passing through it and carrying heat away from both properties. Eco–DC filled this gap by injecting expanding polyurethane foam into it. The insulating foam reduced heat loss and improved the air–tightness within the property.

Floors: U–value 0.193 W/m^2·K

Within the original building the decision was taken to keep the concrete floor slab in the existing rear extension, as it was considered to be unwise to excavate in an area with shallow foundations and existing drainage runs. The slab was made air–tight to the brick walls and painted with a liquid damp proof membrane. The surface was then levelled using a self–levelling concrete compound. Keeping the original floor slab meant there was limited room for insulation.

In order to achieve the best thermal performance for this area of floor and to help the building as a whole stay within the EnerPHit heat loss target, a 100 mm thickness of Kingspan's premium performance *Kingspan* **Kool**therm® K3 Floorboard was installed. An 'intelligent' variable vapour control membrane was laid above the insulation and the build–up was covered with 2 layers of plywood sheeting. The final floor finish was travertine tiles laid on a flexible adhesive.

In the new extension a 40 mm stone base was covered with a concrete skim to level the surface, above this a 250 mm layer of expanded polystyrene insulation was installed followed by a further 200 mm reinforced concrete raft.

Windows: U–value 0.98 W/m^2·K

Some consideration was originally given to maintaining the double–glazed UPVC windows which were already fitted on the front of the house. However, to ensure that the EnerPHit performance standards were met, triple glazed windows were installed. External insulation was then fitted to overlap the window frames in order to minimise heat–loss around the window frame.

The new extension used extra glazing to maximise solar thermal gain within the building, minimising heating usage
(Image courtesy of Simmonds Mills Architects)

Doors: U–value 0.87 $W/m^2 \cdot K$

The original solid timber front door on the property, with a U–value of 4.4 $W/m^2 \cdot K$, was replaced with a high performance triple glazed door, reducing the U–value of the surface by 75%.

Ventilation

To provide ventilation, an MVHR unit was installed where the cottage's original ground floor toilet had been. Air is extracted via ducts from the bathroom, utility, kitchen and upper hallway to the MVHR. In order to minimise the intrusion of ductwork into the cottage's living space, the system was integrated into available hidden spaces such as underneath the floating first storey floor, within voids in the attic room and within the false ceiling above the staircase.

An MVHR drying room was also installed as part of the construction; during the summer the cupboard is used as a means of drying clothes instead of a tumble dryer.

In order to limit the intrusion of ducting within the property, ducting was concealed where possible within floors and walls
(Image courtesy of Simmonds Mills Architects)

Heating

An A–rated gas boiler is used within the house, supplying heating to the cottage's original radiators along with domestic hot water for the property. The boiler is fitted with a weather compensator which uses sensors on the exterior of the house to measure weather conditions, preventing the boiler from firing unnecessarily.

Results

- Estimated Primary Energy demand – 120 $kWh/m^2/yr$.
- Estimated Heating demand – 25 $kWh/m^2/yr$.
- Estimated Heating Load – 13 $kWh/m^2/yr$.
- Since the property's completion, annual electricity and gas usage has reduced to around a quarter of the previous usage (Electric usage has reduced to 3,312 kWh from 13,800 kWh, Gas usage has reduced to *6,937 kWh from 28,000 kWh).*

NB Since the completion of the project, Kingspan has launched its **Kool**therm® K100 *range, offering a thermal conductivity of 0.018 W/m·K across all thicknesses. The expanding range now includes* *Kingspan* **Kool**therm® K103 Floorboard, *which replaces* *Kingspan* **Kool**therm® K3 Floorboard.

Case Study 2: Carnegie Village

Project Name: Carnegie Village

Building Type: New Build
Location: Leeds
Status: Certified
Building Use: Student Residential
U–value Performance of Roof: 0.06 W/m²·K
U–value Performance of External Walls: 0.15 W/m²·K
U–value Performance of Ground Floor: 0.12 W/m²·K
Air Tightness: 0.5 m³/hr/m² at 50 Pa

Kingspan Products Used:
- *Kingspan* **Kool**therm® K3 Floorboard
- *Kingspan* **Kool**therm® K7 Pitched Roof Board
- *Kingspan* **Therma**wall® TW55

Client: Leeds Metropolitan University
Building Services: Imtech G&H Ltd.
Main Contractor: Shepherd Construction
Architects: Goddard Wybor Architects

Introduction

The Carnegie Village student 'eco–residence' at Leeds Metropolitan University is designed to accommodate up to 479 students. As part of the wider development, two joined units (C1 & C2) were built to Passivhaus standard, becoming the UK's first Passivhaus student accommodation. The technical performance details provided for this case study are specific to unit C1 but are representative of the performance from unit C2. The residential units feature several innovations:

- the roof build–up was designed to achieve exceptional thermal performance, far greater than that required for Passivhaus;
- to further improve the overall performance of the units several sustainable features were included, for example lighting in communal areas is controlled using Passive Infra–Red units to minimise energy use; and
- students have access to an online interface allowing them to monitor energy use from their utilities in real–time and recycling schemes integrated into the accommodation.

Technical Summary

Roof: U–value 0.06 W/m²·K

As part of the roof design, the architects provided enough space for an extremely thermally efficient build–up, able to achieve a U–value nearly three times better than required by the Passivhaus standard. To achieve this, first a 200 mm layer of mineral wool insulation was installed; this was followed by a 100 mm layer of *Kingspan* **Kool**therm® K7 Pitched Roof Board fitted between the roof rafters. A further 100 mm layer of *Kingspan* **Kool**therm® K7 Pitched Roof Board insulation was installed below this, helping to minimise thermal bridging and further improve the overall thermal performance of the roof. Finally, layers of 15 mm thick plasterboard were fitted.

The units take full advantage of extra space provided to insulate the roof space, producing outstanding thermal performance
(Image courtesy of Shepherd Construction)

External Walls: U–value 0.16 W/m²·K

To prevent the potential issue of condensation build–up within the external walls, a 53 mm cavity was placed within the brickwork. A 9 mm layer of OSB was then installed, providing the building with the air–tight seal crucial to achieving Passivhaus status. This was followed by a 140 mm layer of mineral wool insulation held in place using timber studs.
In order to minimise the potential issue of thermal bridging resulting from the use of studs and to bring the wall up to Passivhaus standard, a 50 mm layer of *Kingspan* **Therma**wall® TW55 insulation was fitted. Finally a 19 mm service void and two layers of plasterboard were installed.

Careful detailing was used to ensure thermal performance and air–tightness with *Kingspan* **Therma**wall® TW55 cut to insulate around the windows and tape used to improve air–tightness
(Image courtesy of Shepherd Construction)

Floors: U–value 0.12 W/m²·K

On the ground floor of the property a 150 mm reinforced concrete ground bearing slab was laid, providing the floor with an airtight seal. Beneath this, 160 mm of Kingspan's premium performance *Kingspan* **Kool**therm® K3 Floorboard insulation was installed, helping to minimise heat loss through the floor.

Windows and Doors: U–value 1.16 W/m²·K

As standard for Passivhaus applications, the windows on the units were triple–glazed and the doors were internally insulated to reduce both air and heat loss through these features.

Ventilation

In order to provide the essential ventilation to the air–tight units, a heat recovery unit was fitted. The ductwork systems are largely concealed within the walls and floors in order to maximise space within the rooms.

In order to keep the living space uncluttered, ventilation ductwork was largely concealed within the walls and ceilings
(Image courtesy of Shepherd Construction)

Heating

Heating and domestic hot water within the units are provided using an A–rated condensing gas boiler. When necessary additional heating can also be supplied to the properties via a small heat exchanger located within the supply air ductwork of the ventilation system.

Results

- Estimated Primary Heating Demand – 14 kWh/m²/yr.
- Estimated Primary Energy Demand – 63 kWh/m²/yr.
- As one of the highest scoring BREEAM buildings of 2010 with an overall development score of 76.10%, the Carnegie Village Development was also awarded the 2010 BREEAM Multi–Residential Award.

NB Since the completion of the project, Kingspan has launched its **Kool**therm® K100 *range, offering a thermal conductivity of 0.018 W/m·K across all thicknesses. The expanding range now includes Kingspan* **Kool**therm® K103 Floorboard *and Kingspan* **Kool**therm® K107 Pitched Roof Board, *replacing Kingspan* **Kool**therm® K3 Floorboard *and Kingspan* **Kool**therm® K7 Pitched Roof Board *respectively.*

Case Study 3: The Greenhauses

Project Name: The Greenhauses

Building Type: New Build
Location: London
Status: Certified
Building Use: Residential
Construction Time: 26 months
U–value Performance of Roof: 0.15 W/m²·K
U–value Performance of External Walls: 0.10 W/m²·K
U–value Performance of Ground Floor: 0.10 W/m²·K
Air Tightness: 0.6 m³/hr/m² at 50 Pa

Kingspan Products Used:
Kingspan **TEK**® Building System
Kingspan **TEK**® Cladding Panel
Kingspan **Kool**therm® K3 Floorboard
Kingspan **Kool**therm® K12 Framing Board
Clients: Octavia Housing
Main Contractor: Durkan
Architects: Cartwright Pickard Architects

Introduction

Developers, Octavia Housing, appointed Cartwright Pickard to design The Greenhauses in Sulgrave Gardens. The site required careful design and planning due to its shape, urban nature and close proximity to Conservation Areas.

Cartwright Pickard designed the scheme to be arranged in four blocks. It comprised a row of three–storey terraces (Block A), two five–storey apartment buildings (Blocks B & C) and a further four mews houses with roof terraces (Block D). Both Blocks A and B are fully Passivhaus certified, which made The Greenhauses the first mixed–tenure Passivhaus development in London. The Greenhauses development is also London's largest Passivhaus development.

The carefully designed development included several notable features:

- sliding louvres, that provided solar shading to south and south–west facing façade windows. This reduced the thermal gain and controlled the levels of direct light into the building;
- the use of water–efficient appliances led to the indoor water use being 30% less than the UK average, at 105 litres per person per day; and
- a waste management plan was employed across the whole site, which included the monitoring, reporting and setting of resource efficiency targets.

Despite the tight urban site, the building also met the following standards, over and above that required by Passivhaus:

- each of the dwellings were built to Lifetime Homes standards; and
- the building meets Code for Sustainable Homes level 4.

Technical Summary

External Walls: U–value 0.10 W/m²·K

Two approaches were used to insulate and make the properties external walls airtight:

- on Block A, a breather membrane was stapled to the outer face of the *Kingspan* **TEK**® Building System, followed by 90 mm thick *Kingspan* **Kool**therm® K12 Framing Board. A 50 mm cavity was then left between the build–up and the 102.5 mm brickwork facing. An airtight membrane was taped to the inner face of the *Kingspan* **TEK**® Building System, followed by a 25 mm service zone and two 15 mm layers of plasterboard lining; and
- on Block B, the *Kingspan* **TEK**® Cladding Panel was fixed to the concrete floor slab using angled cleats. The build–up mirrored those in Block A. The concrete frame and soffits were sealed using an airtight membrane and airtight tape. The aluminium composite façades, used in certain areas of the exterior on both blocks, were installed on aluminium brackets fixed to timber battens.

The proprietary jointing system featured on both the *Kingspan* **TEK**® Building System and the *Kingspan* **TEK**® Cladding Panel, in combination with the additional airtightness detailing on the project, ensured that air loss from the blocks was below the 0.6 m³/hr/m² @ 50 Pa.

Floors: U–value 0.10 W/m²·K

Two 100 mm layers of *Kingspan* **Kool**therm® K3 Floorboard were installed above a concrete slab on the ground floor of all four blocks. A 25 mm upstand of perimeter insulation was installed at the edge to avoid thermal bridging. Above the insulation a breather membrane was laid. The floor boards were installed as the final layer.

Windows and Doors: U–values 0.80 W/m²·K

The dense urban site limited the amount of winter solar gain for each of the dwellings. Therefore, the glazing is situated on the south façade of the building as much as possible. This issue was realised during the design stage and also lead to the specification of Passivhaus approved high–performance windows and doors, which provided the thermal performance needed to keep the limited thermal gain inside.

Ventilation

To maintain a constant flow of fresh air, Mechanical Ventilation with Heat Recovery (MVHR) systems were installed in all of the blocks, using heat from the outgoing, stale air to warm the incoming, fresh air. Sufficient plant space was worked into the design to accommodate the MVHR units and duct runs.

Heating

Due to the limited amount of light reaching the dwellings, only a small amount of heating could be achieved through solar gain. Therefore, each of the dwellings were fitted with individual gas boilers. The houses on site were also fitted with solar thermal panels as additional heating supply. This provides each dwelling with instantaneous domestic hot water.

Results

- Estimated Heating Demand of less than 15 kWh/m²/yr.
- Estimated total primary energy – 120 kWh/m²/year.
- The projected CO_2 emissions of the site were reduced by 44% due to the high performance building envelope and energy efficient building services. The emissions were reduced by a further 12% by the use of zero carbon technologies, such as dedicated clothes drying areas to reduce the use of drying appliances.

NB Since the completion of the project, Kingspan has launched its **Kool**therm® K100 *range, offering a thermal conductivity of 0.018 W/m·K across all thicknesses. The expanding range now includes Kingspan* **Kool**therm® K103 Floorboard *and Kingspan* **Kool**therm® K112 Framing Board*, replacing Kingspan* **Kool**therm® K3 Floorboard *and Kingspan* **Kool**therm® K12 Framing Board *respectively.*

Case Study 4: The River Studio

Project Name: The River Studio

Building Type: Retrofit
Location: Leamington Spa
Status: Certified
Building Use: Office
U–value Performance of Roof: 0.12 W/m²·K
U–value Performance of External Walls: 0.10 W/m²·K
U–value Performance of Ground Floor: 0.16 W/m²·K
Air Tightness: 0.4 m³/hr/m² at 50 Pa

Kingspan Products Used:
Kingspan **TEK**® Cladding Panel
Kingspan **UNIDEK** aero®
Kingspan **Kool**therm® K3 Floorboard
Kingspan **Therma**wall® TW55
Client: Sjölander da Cruz Architects
Main Contractor: Arden Construction Limited
Architects: Sjölander da Cruz Architects

Introduction

The River Studio, in Leamington Spa, was originally built as a packing shed for a market garden, but in recent years has been converted into the new office for Sjölander da Cruz Architects. The repurposed barn has been stripped of its asbestos clad shell and renovated into an office certified to Passivhaus EnerPHit Standard. As a retrofit, the project posed several issues not commonly found with a new–build Passivhaus:

- the location of the existing building is in the greenbelt; and
- the orientation of the studio and position on site could not be altered, therefore, the thermal gain of the building was predetermined.

Kingspan Insulation's products provided a building envelope solution which allowed the architects to preserve internal space without encroaching on the headroom. This is because products manufactured by Kingspan Insulation are the thinnest commonly used and allowed the architects to preserve the internal space.

Despite the challenges The River Studio faced, it has been involved in the following awards since completion:

- winner of the AJ Retrofit Award; and
- shortlisted for Bespoke Project Design Category at the 2013 Passivhaus Awards.

Technical Summary

Roof: U–value 0.12 W/m²·K

As the existing steel structure was kept intact, this predetermined the height of the office. Therefore, the 254 mm thick *Kingspan* **UNIDEK** aero® roofing system was installed above the steel structure. To eliminate thermal bridging, the *Kingspan* **UNIDEK** aero® roofing panels feature a unique timber rib construction. An 18 mm deck was mechanically fixed to the upper face of the System. An open drainage membrane was fixed above the deck. To finish the build–up a steel roof was installed over the membrane.

External Walls: U–value 0.10 W/m²·K

As part of the external wall build–up 142 mm thick *Kingspan* **TEK**® Cladding Panel was fixed to the concrete floor slab. The existing steel structure was left exposed internally. A 60 mm gap was left between the existing columns and the new external wall. 100 mm thick *Kingspan* **Therma**wall® TW55 was fitted to the outer face of the *Kingspan* **TEK**® Cladding Panel. To finish the exterior, battens for cedar cladding were fixed through the external insulation on cantilevered screws.

A western red timber façade was then fitted. Behind the cladding and the battens, a black insect mesh was installed. The build–up was finished internally with a 15 mm plasterboard.

An airtight tape was applied to all *Kingspan* **TEK**® Cladding Panel junctions inside the studio. This combined with a membrane beneath the roof and floor delivered a final air leakage rate of 0.40 m³/hr/m² at 50 Pa.

Floors: U–value 0.16 W/m²·K

A continuous damp proof membrane was installed above the existing concrete slab and sealed with tape at the junction between the floor and wall. 120 mm of *Kingspan* **Kool**therm® K3 Floorboard was installed above the damp proof membrane. The floor was finished with a 65 mm screed and a 4 mm polyurethane resin on top. Underfloor heating pipes were installed within the floor build-up.

Windows and Doors: U–value 0.89 W/m²·K

To ensure that the EnerPHit performance standards were met, triple–glazed windows were installed on the studio in the pre–cut openings of the *Kingspan* **TEK**® Cladding Panel. The large windows and doors used provided additional light and potential for solar gains. The doors and windows specified had been certified by the Passivhaus Institut and provide excellent thermal performance.

Ventilation

A Passivhaus certified MVHR unit was installed to provide a constant flow of fresh air throughout the building.

Results

- Estimated Energy Demand – 18 kWh/m²yr.
- Surpassed the level of performance required by the EnerPHit standard (25 kWh/m²yr).

NB Since the completion of the project, Kingspan has launched its **Kool**therm® K100 *range, offering a thermal conductivity of 0.018 W/m·K across all thicknesses. The expanding range now includes Kingspan* **Kool**therm® K103 Floorboard*, which replaces Kingspan* **Kool**therm® K3 Floorboard.

Case Study 5: Alexandra Road

Project Name: Alexandra Road

Building Type: New Build
Location: Heaton Moor, Manchester
Status: Certified
Building Use: Residential
U–value Performance of Roof: 0.09 W/m²·K
U–value Performance of External Walls: 0.09 W/m²·K
U–value Performance of Ground Floor: 0.12 W/m²·K
Air Tightness: 0.45 m³/hr/m² at 50 Pa

Kingspan Products Used:
Kingspan **TEK**® Building System
Kingspan **TEK**® Cladding Panel
Client: Steve and Mel Howarth
Main Contractor: Point1 Building Systems
Architects: PHI Architects

Introduction

Self builds are a relatively rare occurrence in the urbanised South Manchester region, so when Steve and Mel Howarth came across an available plot, they were eager to ensure it was put to good use. 40 Alexandra Road combines modern styling with a high–performance building envelope that achieves full Passivhaus Certification.

The couple wanted to utilise offsite construction methods on the project and asked PHI Architects to incorporate structural insulated panels within their design. After considerable research, PHI selected the *Kingspan* **TEK**® Building System to form the walls and roof of the structure. The firm worked closely with highly experienced *Kingspan* **TEK**® Delivery Partners, Point1 Building Systems.

The *Kingspan* **TEK**® Building System provided a number of benefits for the project:

- the panel's proprietary jointing system and OSB/3 facing allowed design features to be achieved without increasing air loss through the building envelope;
- their excellent spanning capacity allowed first floor rooms to be designed with open 'vaulted' ceilings, creating a feeling of space and light;
- the low thermal conductivity of the panels allowed wall thicknesses to be minimised on the tight plot; and
- continuity of insulation at joints within the building envelope helped to limit thermal bridging.

Technical Summary

Roof: 0.09 W/m²·K

The *Kingspan* **TEK**® Building System panels were installed onto glulam beams as required at ridge and internal supports. A breather membrane was fixed to the outer face of the panels. Timber battens were then installed along with a 60 mm layer of woodfibre insulation and artificial slate tiles.

Internally, an airtight membrane was fitted and tape was applied to all junctions. This was followed by a 50 mm layer of woodfibre insulation and a plasterboard facing.

External Walls: 0.09 W/m²·K

Point1 Building Systems erected the *Kingspan* **TEK**® Building System panels, fitting a breather membrane to their outer face. A render system, insulated with woodfibre insulation, was installed externally with a rainscreen cavity. The internal construction was identical to the roof with an airtight membrane, 50 mm layer of wood fibre followed by plasterboard.

Floors: 0.12 W/m²·K

For the ground floor construction, a 300 mm thickness of extruded polystyrene insulation was installed beneath a reinforced concrete raft ground bearing slab. An airtight membrane was fitted on top of the slab and the surface was then screeded to a finish.

Windows and Doors: 0.6 W/m²·K

Triple glazed windows with an aluminium external facing were installed in pre–cut openings within the *Kingspan* **TEK**® Building System panels.

Ventilation

A Passivhaus certified MVHR unit was installed to provide a constant flow of fresh air throughout the building.

Results

- Heating Demand – 19 kWh(m²a).
- Heating Load – 10 W/m²·K.

Case Study 6: Lena Gardens

Project Name: Lena Gardens

Building Type: Retrofit
Location: London
Status: Certified
Building Use: Private Residential
U–value Performance of Roof: 0.14 $W/m^2 \cdot K$
U–value Performance of External Walls: 0.10 $W/m^2 \cdot K$
U–value Performance of Ground Floor: 0.11 $W/m^2 \cdot K$
Air Tightness: 0.49 $m^3/hr/m^2$ at 50 Pa

Kingspan Products Used:
Kingspan **Kool**therm® K7 Pitched Roof Board
Kingspan **Kool**therm® K12 Framing Board
Kingspan **Therma**floor® TF70
Client: Private
Low Energy House Designers: Green Tomato Energy, Princedale Ecohaus Ltd
Architects: Macmillan–Scott Practice

Introduction

The property in Lena Gardens is a Victorian mid–terrace constructed in the 1870's. As a retrofit the project posed several issues not commonly found with a new–build Passivhaus:

- the building's features resulted in more irregular layouts and junctions than found in a purpose built Passivhaus, for example, fire places needed to be removed and chimney pots closed off and propped;
- the structure features solid brick walls, preventing the use of cavity wall insulation; and
- the building's location within a Hammersmith conservation area prevented most external alterations, meaning all insulation had to be fitted internally.

Detailing was a major priority for project designers Philip Proffit (Princedale Ecohaus Ltd) and Edward Borgstein (Green Tomato Energy) in order to prevent thermal bridging and to form the building's air–tight seal. The thermal efficiency of Kingspan's insulation similarly played a vital role in the success of the project, providing the required thermal performance with the minimum thicknesses of insulation, keeping internal space at a maximum. The insulation in combination with the triple glazing and air–tightening, also helped to sound–proof the house, turning it into a warm, tranquil environment, quite apart from the busy Hammersmith street outside.

During the retrofit process, the homeowners also took the opportunity to expand the house, adding a loft conversion along with a side–return extension of the kitchen at the rear of the property (the flat roof of the extension was used for green roofing). The combination of these extensions, the removal of fireplaces and the minimal thicknesses of Kingspan's insulation, meant that despite the additional internal insulation, overall space within the property was actually increased. The architectural adjustments to the property were overseen by the Macmillan–Scott Practice.

Technical Summary

Roof: U–value 0.14 $W/m^2 \cdot K$

The property features a pitched roof over the main terrace house and flat roofing over the rear Kitchen extension. In both cases the same build–up was used to insulate the roof and keep the property air–tight. Initially a 130 mm thickness of *Kingspan* **Kool**therm® K7 Pitched Roof Board was fitted between the rafters. This was followed by a layer of OSB, which runs continuously through the walls, under floors and ceilings in the property, and was sealed around joints using tape to form the air–tight seal. Another 50 mm layer of *Kingspan* **Kool**therm® K7 Pitched Roof Board was then installed, followed by a layer of plasterboard.

130 mm of *Kingspan* **Kool**therm®, fitted between the roof rafters, provided the first layer of insulation to the roof of the property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External Walls: U–value 0.10 W/m²·K

For the external walls, 130 mm of *Kingspan* **Kool**therm® K12 Framing Board was installed, followed by the air–tight OSB layer, and a further 50 mm of *Kingspan* **Kool**therm® K12 Framing Board followed by a layer of plaster. Tricky junctions and surface penetrations were carefully designed and planned.

External and party walls were fitted with a continuous layer formed from OSB board, taped together, to provide the building with an air–tight seal

Party Walls: U–value 0.27 W/m²·K

As a middle–terrace, the house was particularly vulnerable to heat–loss due to poorer insulated neighbouring properties. A 50 mm layer of *Kingspan* **Kool**therm® K12 Framing Board was therefore installed along all party walls along with the continuous OSB layer, protecting the property from thermal bridging and ensuring the air seal.

Floors: U–value 0.11 W/m²·K

In order to minimise thermal bridging and to remove the risk of the timbers rotting, all floor joists were rehung inside the thermal envelope. Due to their poor condition, the second and third floor joists were replaced entirely. Three build–ups were then used to reduce heat–loss through the ground and basement floors:

- under the basement floor a ground–to–air heat exchanger was installed. 150 mm of *Kingspan* **Therma**floor® TF70 was then installed over the heat exchanger and beneath a floating plywood floor;
- in order to insulate the suspended floor alongside the basement, the floor joists were lowered to allow the installation of 200 mm *Kingspan* **Therma**floor® TF70 above the joists. A tongue and grooved chipboard floating floor was then installed above this; and

Upper level floor joists were rehung on steel joists, allowing a continuous layer of insulation to be formed on the external walls, limiting thermal bridging

- in the ground–floor kitchen, the original concrete floor slab was removed and 150 mm of *Kingspan* **Therma**floor® TF70 was installed over the compacted hardcore. A further 150 mm concrete slab was then installed above this.

Windows: U–value 0.89 W/m²·K

The triple glazed windows were designed for the project by Philip Proffit from Princedale Ecohaus Ltd. In order to obtain planning permission the windows were designed in a sash imitation style. The window installation also took advantage of the period sash boxes, originally used to conceal the counterweights for the sash windows. Filling these boxes with *Kingspan* **Kool**therm® K12 Framing Board helped to minimise thermal bridging around the windows. The window frames were taped to the OSB layer to ensure the air–tight seal.

Carefully planned detailing was extremely important on the build in order to minimise heat and air–loss through tricky junctions such as the new roof lights in the loft conversion

Doors

Glazed Doors: U–value 0.85 W/m²·K,

Opaque Doors: U–value 1.00 W/m²·K

The external doors were purpose built in order to meet the "London Doors" aesthetic. The doors were triple glazed and fitted internally with a layer of *Kingspan* **Kool**therm® K12 Framing Board to ensure thermal performance. As with the windows, the door frames were taped to the OSB layer to ensure the house remained air–tight.

Ventilation

Good ventilation is essential in very airtight construction. Ventilation within the property was provided via a Genex Combi 185L unit, featuring a heat recovery efficiency of 76%, which was installed within the basement. A metal sprial ductwork system was then installed throughout the house to provide ventilation. Internal intrusion within the house from the ductwork system was minimised by using floor and ceiling grids and keeping the ductwork within floor voids and stud walls where possible.

Heating

Heat supply within the house is provided via the use of an air–to–air pump within the Genex Combi Unit. Further heating is provided, when necessary, via the use of a direct electric heating coil within the spring ductwork system. The ground–to–air heat exchanger fitted beneath the basement floor provides additional winter pre–heating and summer cooling, along with frost protection, to the building. Water is primarily heated by the 3–panel solar thermal array installed on the roof. When this proves insufficient, the air source pump within the Combi Unit is capable of functioning as an air–to–water heater, providing additional hot water.

A labyrinthian heat exchanger was fitted under the basement floor, using the more constant temperature of the ground to provide cooling in the summer and pre–heating in the winter
(Image courtesy of Green Tomato Energy)

Results

- Estimated Primary Energy demand – 120 kWh/m²/yr.
- Estimated Primary Heating demand – 15 kWh/m²/yr.
- Gas usage is now reduced to insignificant amounts used solely for cooking.
- Initial performance testing for the first six months of 2011 showed a metered usage of only 1.8 MW.h and an estimate of 5.35 MW.h for annual consumption, around 10% of previous metered consumption.
- The performance test values also suggested the actual specific primary energy demand was nearer two–thirds of the predicted demand (54.8 kWh/m²/yr compared with the predicted 72 kWh/m²/yr).

NB Since the completion of the project, Kingspan has launched its **Kool**therm® K100 *range, offering a thermal conductivity of 0.018 W/m·K across all thicknesses. The expanding range now includes Kingspan* **Kool**therm® K107 Pitched Roof Board *and Kingspan* **Kool**therm® K112 Framing Board, *replacing Kingspan* **Kool**therm® K7 Pitched Roof Board *and Kingspan* **Kool**therm® K12 Framing Board *respectively.*

Case Study 7: Princedale Road

Project Name: 100 Princedale Road

Building Type: Retrofit	**Kingspan Products Used:**
Location: London	*Kingspan* **Thermafloor**® TF70
Status: Certified	*Kingspan* **Thermawall**® TW55
Building Use: Private Residential	**Client:** Octavia Housing
U–value Performance of Roof: 0.15 W/m²·K	**Main Contractor:** Princedale Ecohaus Ltd.
U–value Performance of External Walls: 0.10 W/m²·K	**Architects:** Paul Davis + Partners
U–value Performance of Ground Floor: 0.14 W/m²·K	**Project Management:** Green Tomato Energy
Air–Tightness: 0.5m³/hr/m² at 50 Pa	**Sustainability Consultants:** Eight Associates

Introduction

Built in the 1850's, 100 Princedale Road is the first retrofit to be awarded Passivhaus certification in the UK. The terrace's age, and its location within central London, led to several additional challenges as part of the build:

- the building is located within the Holland Park Conservation Area. This prevented the use of external insulation and meant that windows and doors had to be specially designed to match the period style;
- the property also features solid brick walls which prevent the use of cavity wall insulation; and
- as a retrofit, the building featured more challenging junctions and room designs than would be found in a purpose built Passivhaus. This meant detailing had to be carefully planned and carried out.

Given the building's relatively small size, and the fact that all insulation had to be fitted internally, space–saving was a major priority on the retrofit. The ability of *Kingspan* **Thermawall**® TW55 and *Kingspan* **Thermafloor**® TF70 to achieve the high thermal performance standards required for Passivhaus constructions, with the minimum thickness, was therefore fundamental to the building's success. The removal of fireplaces as part of air–tightening the structure further helped to minimise internal loss of space.

Careful consideration was also given to the fact that the building's purpose was to be rented by owners Octavia Housing. To best ensure their social tenants could avoid falling into fuel poverty as much as possible, other additional measures were installed to complement the new energy efficient building fabric. The extra energy saving features were therefore built into the house, with all light fittings being replaced with low energy versions and all appliances rated to A++ standard as a minimum.

Technical Summary

Roof: U–value 0.15 W/m²·K

To insulate and make air–tight the pitched roof, a 130 mm thickness of *Kingspan* **Thermawall**® TW55 was fitted between the rafters. This was followed by a 12 mm layer of OSB, which runs continuously throughout the property, and is sealed around windows, doors and other junctions using tape, forming an air–tight seal. A further 50 mm layer of *Kingspan* **Thermawall**® TW55 was then installed, ensuring the property achieved the high thermal performance required by the Passivhaus standard, followed by a layer of plasterboard.

External Walls: U–value 0.10 W/m²·K

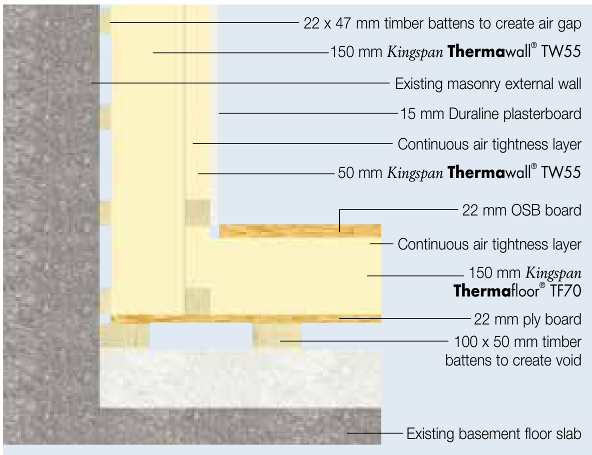
As part of the external wall build–up a 25 mm vented cavity was left between the brickwork and the insulation, preventing the accumulation of condensation within the wall. 150 mm of *Kingspan* **Thermawall**® TW55 was then installed, followed by the air–tight OSB layer. As with the roof a further 50 mm of *Kingspan* **Thermawall**® TW55 was installed to allow for a service zone where sockets can be fitted without perforating the airtight layer, and then finally a layer of plasterboard was added. Junctions and surface penetrations were carefully designed and planned to minimise both heat–loss as a result of thermal bridging and air–leakage.

Party Walls: U–value 0.27 W/m²·K

To minimise air–leakage and heat loss to adjoining properties, party walls were insulated with a build–up of 25 mm *Kingspan* **Thermawall**® TW55 followed by the 12 mm OSB to ensure air–tightness, then a further 25 mm thickness of *Kingspan* **Thermawall**® TW55 finished with the plasterboard. The build–up was installed using adhesive rather than metal or plastic fixings, to further minimise thermal bridging.

Floors: U–value 0.14 $W/m^2 \cdot K$

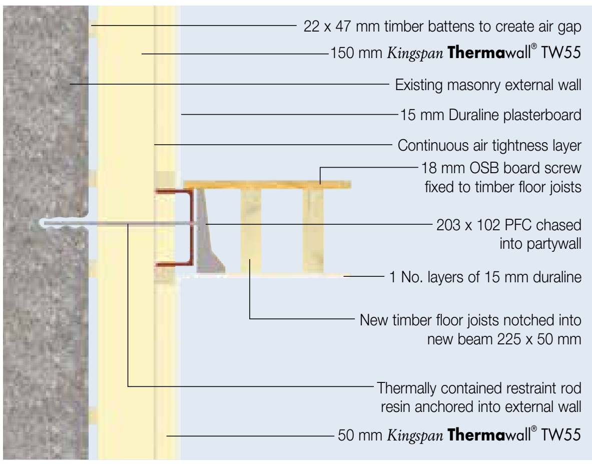
As part of the retrofit, the basement floor was first fitted with a labyrinthine, ground–to–air heat exchanger. Above the heat–exchanger an air–tight layer of OSB was installed, followed by 150 mm of *Kingspan* **Therma**floor® TF70.



150 mm of *Kingspan* **Therma**floor® TF70 was fitted as part of the basement floor build–up, ensuring its thermal performance

A key challenge with buildings using internal insulation and air–tight layers is the void between floors where joists are embedded in external walls, leading to a risk of increased air–leakage and heat loss as a result of thermal bridging.

To tackle this issue on the Princedale Road project, the original floor joists were cut back from the walls and a steel joist, bearing on the property's party walls, was positioned to take the load of the new timber joists.



Intermediate floor detail minimising thermal bridging

Thermal bridging was a major issue with the original timber joists fitted into the external wall. To minimise this new floor joists were fitted and attached to a steel beam, bearing on the party walls, providing a gap for a continuous layer of insulation and OSB to be fitted on the external wall, minimising heat and air loss
(Images courtesy of Paul Davis + Partners)

This innovation created a void which adjoined the external walls across all three floors. Within this void the *Kingspan* **Therma**wall® TW55 insulation and OSB layers could then be installed without interruption, greatly improving the property's thermal performance and air–tightness. In order to minimise heat loss at the ends of the steel beams, they were mounted in foam glass, resulting in U–values of only 0.2 $W/m^2 \cdot K$ at the thermal bridge at either end.

Windows: U–value 0.58 $W/m^2 \cdot K$

In order to comply with the local authority conservation area constraints, the windows for the house had to be designed to mimic the original sash window design form the outside. The bespoke windows were designed by Philip Proffit of Princedale Ecohaus Ltd. with the bottom sash appearing to be a sliding sash but actually acting as a tilt and turn lower portion. The windows are triple–glazed.

In order to comply with local planning rules, triple glazed imitation sash windows were specially designed and fitted
(Image courtesy of Octavia Housing)

Doors: U–value 0.6 W/m²·K

As with the windows, the front door to the property had to be specially designed in order to comply with local planning requirements. The door is filled internally with a layer of *Kingspan* **Therma**wall® TW55 insulation while the exterior frame of the door is taped to the OSB layers to ensure the building remains air–tight.

Ventilation

An MVHR unit, installed within the basement, provides the controlled ventilation for the property. A galvanised spiral metal pipe ducting system was used to allow the unit to ventilate the house. Careful consideration was also taken over the positioning of the ductwork system throughout the house in order to limit further intrusion into room space. As a result much of the ductwork was installed under floors.

Heating

Primary heating in the house is supplied via the air to air pump within the MVHR unit, with an additional bypass system to reduce air heating during the summer. The labyrinthine ground–to–air heat exchanger under the basement floor uses the relatively constant ground temperatures to provide additional pre–heating for air in the winter, and cooling during the summer.

An MVHR unit, fitted within the basement, is the primary source of both heating and ventilation within the property
(Image courtesy of Octavia Housing)

Around two thirds of hot water in the property is provided by a solar–thermal drain back system using three solar panels installed on the south facing roof. The roof design, which includes a continuous parapet, means that the panels are not visible from the road; this was the primary reason that their installation was allowed despite the strict restrictions on external alterations. The solar–thermal drain back systems can be supplemented when necessary via an air–to–water pump in the MVHR unit.

Results

- Primary Energy Demand – 80 kWh/m²/yr.
- Estimated Primary Heating demand – 10 kWh/m²/yr.
- CO_2 emissions of only 15 kg CO_2/m²/year.
- The Passivhaus retrofit resulted in a reduction of over £1,600 in annual heating and energy bills (from £2,080 to £397). Assuming an annual increase in bills of 10% year on year, this would mean the property would pay back the cost of retrofit in savings in around 17 years. If no retrofit had been done, the bills would have reached almost £100 per week in 10 years time.

Find out more about the project at www.greenoctavia.org.uk.

OCTAVIA HOUSING

Case Study 8: Jersey EnerPHit

Project Name: Le Jardin de Bas

Building Type: Retrofit
Location: Jersey
Status: Certified
Building Use: Residential
U–value Performance of Roof: 0.18 W/m²·K
U–value Performance of External Walls: 0.16 W/m²·K
Air Tightness: 1 m³/hr/m² at 50 Pa

Kingspan Products Used:
Kingspan **TEK**® Building System
Kingspan **Kool**therm® K5 External Wall Board
Main Contractor: JecoHomes Ltd

Introduction

Property experts have long stated that the three most important factors when buying a property are "location, location, location". For homeowners looking to create low energy properties, this often means finding an ideal plot, demolishing the existing building and starting afresh. Whilst (in theory at least) this approach is much simpler than upgrading the existing property, it is also inherently wasteful.

This family home in Jersey shows that creating a dream, energy–efficient property, doesn't have to mean compromising on sustainable principles. Through the use of the *Kingspan* **TEK**® Building System, the dated, poorly insulated bungalow has been transformed into a modern, 3–bedroom home which meets the requirements of the Passivhaus EnerPHit Standard.

The retrofit work on Le Jardin de Bas includes a sizeable extension and a new roofspace to create room for attic bedrooms, both fabricated from the *Kingspan* **TEK**® Building System. Despite the extensive works, little of the original building has gone to waste, with tiles and blockwork crushed to form hardcore, and timbers re–used within the extension.

The project is an outstanding example of the *Kingspan* **TEK**® Building System's ability to deliver excellent fabric performance on even the most challenging refurbishment, with a fast, predictable and cost–effective build programme.

Technical Summary

Roof: 0.18 W/m²·K

The *Kingspan* **TEK**® Building System panels were installed above both the new and existing walls to form a pitched roof. A breather membrane was applied to the outer face along with a 50 mm thickness of *Kingspan* **Kool**therm® K5 External Wall Board and slate roof tiles. Airtight tape was applied to all junctions internally followed by a layer of plasterboard on timber battens.

The *Kingspan* **TEK**® Building System was also used to form the body of dormer windows in several locations on the roof. These elements were clad with sheet metal.

External Walls: 0.16 W/m²·K

As with the roof, the external walls were primarily formed using the *Kingspan* **TEK**® Building System panels, with a breather membrane and *Kingspan* **Kool**therm® K5 External Wall Board fitted on the outer face. Timber cladding was then fitted on battens. Airtight tape and plasterboard was again installed internally.

The existing walls were stripped back to the original breeze blocks and a layer of external insulation was installed followed with a render finish.

Windows and Doors:

Triple glazed windows and doors were installed throughout the property.

Ventilation

A Passivhaus certified MVHR unit was installed to provide a constant flow of fresh air throughout the building.

Heating

The property's hot water is generated through a combination of solar panels and an air–source heat pump. The only other sources of heat are electric towel radiators and a small wood–burning stove in the sitting room.

Results

Occupants have reported their energy bills are only just over £100 a month.

Case Study 9: Totnes Passivhaus

Project Name: Totnes Passivhaus

Building Type: Retrofit
Location: Devon
Status: Certified
Building Use: Residential
U–value Performance of Roof: 0.10 W/m²·K
U–value Performance of External Walls: 0.09 W/m²·K
U–value Performance of Ground Floor (existing / new):
0.20 / 0.08 W/m²·K
Air Tightness: 0.2 m³/hr/m² at 50 Pa

Kingspan Products Used:
Kingspan **Kool**therm® K3 Floorboard
Kingspan **Kool**therm® K5 External Wall Board
Clients: Private Clients
Main Contractor: Williams & Partners
Architects: CTT Sustainable Architecture

Introduction

A refurbished dwelling in Devon, originally built in the 1960's, has been certified to Passivhaus EnerPHit Standard, becoming the UK's first Passivhaus bed and breakfast. As a retrofit, the project posed several issues not commonly found with a new–build Passivhaus:

- the existing floor slab was too costly to change and to avoid compromising on the height of the rooms, the insulation on the walls and roofs had to compensate for under insulating the existing floor; and
- the orientation of the dwelling and position on site could not be altered, therefore, the thermal gain of the building was predetermined.

Kingspan's insulation products were key to achieving Passivhaus EnerPHit certification. Headroom inside the dwelling was restricted, which limited the floor build up. However, Kingspan Insulation's products helped to provide a solution, which allowed the homeowners to preserve internal space without encroaching on the headroom. The products manufactured by Kingspan Insulation are the thinnest commonly used and allowed for over compensation on the roof and walls, whilst not compromising on the internal space.

During the retrofit process, the clients took the opportunity to extend the property, adding a 30 m² timber frame extension, that was to serve as the new entrance to the dwelling. The dwelling has now been opened up as a bed and breakfast.

Technical Summary

Roof: U–value 0.10 W/m²·K

Two different approaches were used to insulate and make airtight the property's roof, one for the roof of the existing dwelling and one for the roof of the extension. Both roof build–ups achieved the same U–value:

- on the existing dwelling, a new roof was installed. The new roof comprised 24 mm woodfibre board externally, followed below by I–joists underneath. In between the joists, 350 mm of cellulose insulation was installed, made from recycled newspaper. Underneath the joists was a 50 mm service cavity insulated with sheep's wool. A plasterboard ceiling was installed internally; and
- for the roof of the extension, the roof comprised a timber deck with a plaster board ceiling. A living roof was installed externally, which was planted with local wildflowers. Within the build–up of the roof, each timber joist was insulated with 350 mm cellulose insulation. A 75 mm cavity was then insulated with 75 mm thick sheep's wool. A plasterboard ceiling was installed internally.

External Walls: U–value 0.09 W/m²·K

Two different approaches were used to insulate and make airtight the property's external walls, one for the walls of the existing dwelling and one for the walls of the extension. Both external wall build–ups achieved the same U–value:

- the existing external wall consisted of an inner and outer leaf of 100 mm thick blockwork with a 50 mm cavity inside the two leafs. 180 mm *Kingspan* **Kool**therm® K5 External Wall Board was installed on the external face of the outer leaf. The 50 mm cavity was filled with polystyrene bead insulation. Some areas of the existing external wall were close to collapse, they were rebuilt with concrete blocks and the build–up for these areas was the same as above; and
- the external walls of the new extension were built using a timber frame structure. On the outside of the timber frame a 24 mm fibre board was installed. The timber frame was insulated with 400 mm cellulose insulation. This was followed internally by a 50 mm service cavity, which was insulated with sheep's wool. A plasterboard was installed to finish the build–up.

Floors: U–value (existing / new) 0.20 W/m²·K / 0.08 W/m²·K
As insulating the existing floor substantially would have affected the height of the rooms substantially and caused great expense, two different approaches were used to insulate and make airtight the property's floors, one for the floor of the existing floor and one for the floor of the extension. The two build–ups had different U–value results:

- for the existing floor, the 150 mm concrete slab was left in place. Above the concrete slab a 10 mm plaster was installed. The slab was insulated with 80 mm of *Kingspan* **Kool**therm® K3 Floorboard and 20 mm woodfibre insulation on top. The floor was finished using a 14.5 mm hardwood floor with 2 mm foam underlay. Foamed glass gravel insulating aggregate was installed outside the three perimeter walls; and
- for the floor in the extension, a 150 mm concrete slab was installed. This was insulated with 50 mm sheep's wool and 200 mm PIR insulation. The floor was finished using a 14.5 mm hardwood floor and 20 mm woodfibre insulation. Two courses of foam glass insulating blocks were added to the perimeter under the slab.

Windows and Doors: U–values 0.75 – 0.93 W/m²·K
Passivhaus certified triple glazed widows were installed into the existing dwelling and extension. The windows installed had integrated blinds to provide shading in the summertime and avoid overheating. The glazing was filled with argon to improve efficiency. Due to the more mild climate of Devon the window U–value of 0.93 W/m²·K was acceptable.

Ventilation
A Passivhaus certified MVHR unit was installed to provide a constant flow of fresh air throughout the building.

Heating
The MVHR unit includes a small duct radiator that is fuelled by a gas boiler. 9.4 m² of roof–integrated solar thermal and photovoltaic panels were also installed. The solar thermal panels have a 500 litre thermal store. However, due to planning constraints both had to be west–facing, which limited the generation of heating and electricity, especially in the winter months.

Results

- Measured Heating Demand – 13 kWh/m²/yr.
- Measured total primary energy – 76 kWh/m²/year.
- Winner of private housing award at the 2013 UK Passivhaus Awards.

NB Since the completion of the project, Kingspan has launched its **Kool**therm® K100 *range, offering a thermal conductivity of 0.018 W/m·K across all thicknesses. The expanding range now includes Kingspan* **Kool**therm® K103 Floorboard, *which replaces Kingspan* **Kool**therm® K3 Floorboard.

Case Study 10: Highland Housing Expo

Project Name: Highland Housing Expo

Building Type: New Build
Location: Inverness
Status: Awaiting final certification
Building Use: Residential
U–value Performance of Roof: 0.10 W/m²·K
U–value Performance of External Walls: 0.10 W/m²·K
U–value Performance of Ground Floor: 0.10 W/m²·K
Air Tightness: 0.6 m³/hr/m² at 50 Pa

Kingspan Products Used:
Kingspan **Therma**floor® TF70
Kingspan **Therma**pitch® TP10
Kingspan **Therma**wall® TW50
Client: Highland Housing Alliance
Main Contractors: O'Brien Homes
Architects: HLM Architects

Introduction

The 2010 Highland Housing Expo was an opportunity for architects and builders to showcase a range of future housing designs. For their display units, HLM Architects designed a row of three Passivhaus standard terraced houses. As purpose built Passivhaus structures, the terrace houses include several notable features:

- south–facing orientation of large living area glazing, allows the houses to be primarily heated naturally via solar gain;
- each house features a double storey living area which can be opened up to include the dining and kitchen, making the most of the limited available space; and
- the building is clad in home grown Scottish Larch from a sustainable source with 60 miles of the terrace's location.

The terrace at the Highland Housing Expo represented HLM architect's first Passivhaus venture and initially the project aimed to construct and insulate the external walls and roof of the structure using only a prefabricated cassette system. It became apparent however that this would not provide the thermal performance required to achieve Passivhaus status. Not wanting to compromise on the building's unique design, HLM instead turned to Kingspan's **Therma**™ range of insulation to bring the roof and walls of the property up to Passivhaus standard.

Technical Summary

Roof: U–value 0.10 W/m²·K

The roofing and external walls on the terrace were primarily constructed from a prefabricated cassette system. This system consisted of a breather membrane and layer of OSB, followed by I–joists pre–insulated with 250 mm of glass wool insulation. The I–joists were followed with a further 10 mm layer of OSB and a vapour barrier, improving airtightness and preventing moisture build–up. A 50 mm layer of *Kingspan* **Therma**pitch® TP10 insulation was fitted to the bottom of the prefabricated cassette helping to minimise heat loss through the surface.

A breather membrane was used as part of the roof build–up to provide an extra layer of water proofing
(Image courtesy of HLM Architects)

External Walls: U–value 0.10 W/m²·K

The external walls are clad in the locally sourced Scottish Larch and vertical fibre cement board followed by a 50 mm void. The same prefabricated cassette system as used on the roof was then also installed for the external walls, followed by a 40 mm layer of *Kingspan* **Therma**wall® TW55 insulation fitted within a 50 mm void in the build–up. The *Kingspan* **Therma**wall® TW55 insulation again helped to bring the overall build–up to the thermal standard required for Passivhaus. The internal section of the build–up was finished with 125 mm of plasterboard.

A breather membrane was used as part of the roof build–up to provide an extra layer of water proofing
(Image courtesy of HLM Architects)

Floors: U–value 0.10 W/m²·K

The ground floors of the units are built on a 250 mm hardcore with a 50 mm sand binding. Above this a layer of damp proofing was fitted followed by 200 mm of *Kingspan* **Therma**floor® TF70 insulation, helping to minimise heat loss through the floor. Finally the build–up was topped with a 150 mm ground bearing concrete slab, providing an air–tight finish.

Windows and Doors: U–value 0.71 W/m²·K

Large triple glazed windows and triple glazed rooflights were used in order to provide additional light and potential for solar gains. The glazed doors for the property were Passivhaus certified, providing excellent thermal performance.

Rooflights were installed on the terraces to maximise solar gains helping to reduce heating bills
(Image courtesy of HLM Architects)

Ventilation

An MVHR Unit was used to provide ventilation within the property. In order to maintain the terrace house's clean internal look, and retain internal living space, the 100–125 mm diameter ductwork, used as part of the ventilation system, was hidden within first floor and loft floor cassettes.

Ventilation ductwork was concealed within roof and wall space and OSB board used to minimise air–loss
(Image courtesy of HLM Architects)

Heating

Heating within the property is predominantly achieved through solar gain from the large south facing windows in the living areas, internal gains from the inhabitants and recovered heat retained by the MVHR unit. Additional heating is provided via heated towel rails in bathrooms and supply air duct heater batteries within the properties' ductwork systems.
Domestic hot water is supplied by an un–vented cylinder served by an air source heat pump, with additional hot water supplied, when necessary, via an electric–source immersion heater.

Results

- Primary Energy Demand – 109 kWh/m²/yr.
- Primary Heating Demand – 14 kWh/m²/yr.
- The terrace has won several design and sustainability awards and commendations including The Environmental Excellence Award at the Scottish Home Awards 2011.

Contact Details

Customer Service

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

Tel: +44 (0) 1544 388 601
Fax: +44 (0) 1544 388 888
email: customerservice@kingspaninsulation.co.uk

Literature & Samples

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

For copies please contact the Kingspan Insulation Marketing Department, or visit the Kingspan Insulation website, using the details below:

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Tapered Roofing

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

Tel: +44 (0) 1544 387 383
Fax: +44 (0) 1544 387 483
email: tapered@kingspaninsulation.co.uk

Technical Advice / Design

Kingspan Insulation supports all of its products with a comprehensive Technical Advisory Service. Calculations can be carried out to provide U–values, condensation / dew point risk, required insulation thicknesses etc…

U–value calculations can also be carried out on the Kingspan Insulation U–value Calculator, available for free online at www.uvalue-calculator.co.uk or downloaded as an App.

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

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

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

Tel: +44 (0) 1544 387 382
Fax: +44 (0) 1544 387 482
email: technical@kingspaninsulation.co.uk

General Enquiries

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

Tel: +44 (0) 1544 388 601
Fax: +44 (0) 1544 388 888
email: info@kingspaninsulation.co.uk

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Kingspan Insulation Ltd
Pembridge, Leominster, Herefordshire HR6 9LA, UK
www.kingspaninsulation.co.uk