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Room to breathe

Using external insulation can be very effective, but on historic buildings needs to take into account issues such as appearance and a building’s ability to ‘breathe’. Paul Mallion discusses how these were handled on the refurbishment of a Grade II listed farmhouse

Thermally upgrading our existing buildings is widely acknowledged as paramount to reducing energy consumption and carbon emissions. When historic buildings are involved, however, particular care is required to ensure that any proposed energy efficiency measures are not detrimental to the fabric or character of the building.

Generally, intervention to the fabric should be minimised and if possible any changes should be reversible. Survey and research information will help to ensure that any proposed measures are compatible with these aims – this is crucial as many modern impervious materials or membranes are incompatible with traditional permeable construction; upsetting a building’s ability to ‘breathe’ can cause a build-up of moisture in its fabric.

Tyland Farmhouse

The Grade II listed Tyland Farmhouse is one of a collection of buildings near Maidstone in Kent owned by Kent Wildlife Trust. In 2007, the Trust decided to convert the dilapidated farmhouse into additional office space while complying with its strict policies on the environment and nature conservation. Improving the building’s energy efficiency was a key objective.

Originally a timber-framed cottage over three storeys with a thatched roof, the farmhouse was constructed in three bays and dates from the late 16th/early 17th centuries. Many alterations, repairs and extensions were evident, including a full-width catslide extension at the rear.

All of the ground floor walls of the main house up to the first-floor plate had been replaced with nine-inch brickwork to cure severe subsidence, but leaving a considerable slope in the floor and roof. The roof structure

over the west bay consisted of a ‘forest’ of undersized timbers, many little more than quarter-sawn branches.

Multiple layers of dense sand cement render covered all external walls, in some places up to 80mm thick, including interlayers of bitumen, metal lath and other coatings. Removal of the render was essential to prevent further structural deterioration of the timber frame and damage to the brickwork, but would have a considerable effect on the appearance, especially around the windows. The conservation officer agreed that the external render should be removed but the replacement material had to be compatible with the existing structure, provide a visually appropriate external finish and be breathable.

Research was undertaken to find a breathable system compatible with timber frame and solid wall construction, and one that could be finished with a lime render. Cork and woodfibre were identified as the most

Insulation	Embodied energy ¹ MJ/kg	Embodied carbon kg CO ₂ /kg	K Value W/mK	Density kg/m ³
Woodfibre board	11-15	0.72-0.96	0.048	265
Expanded cork board	4.00	0.19	0.04	110-60
Polyurethane board	101.50	3.48	0.026	30
Expanded polystyrene board	88.6	2.55	0.034	15-30

Table 1 – Comparison of insulation types



Left: Insulation boards applied over rafters, with wool between, with a Tyvek membrane, counter battens and battens



Left below: Woodfibre insulation applied to brickwork, with a first coat of lime render applied to left flank wall

suitable owing to their proven performance. Woodfibre is available from Steico and Natural Building Technology. At the time, Steico was in the process of assessing its 'Protect' boards with Lime Green, which manufactures lime plasters. This timely collaboration allowed the project to benefit from keen pricing and plenty of onsite technical assistance.

An understanding of materials is essential when considering the sustainability of a project and should look at, for example, embodied energy, environmental impact, thermal performance and density (dense materials provide better protection against overheating in the summer, compared with very light foamed insulations). See Table 1.

Steico Protect woodfibre was selected for its compatibility with both brickwork and timber frame and its other sustainable properties. For the areas of brickwork, a

stainless steel starter channel was fixed to the wall at DPC level to ensure that the insulation board ran horizontally. Although the channel does act as a thermal bridge to some degree, it protects the exposed bottom face of the insulation and supports the render drip bead.

The brickwork required a thin levelling coat of lime render to form a flat surface for the fixing of the boards, as gaps behind the insulation dramatically reduce the effective U-value through 'thermal bypass'. Insulation boards were tongued and grooved for good fit and laid in stretcher bond. Five thermally broken Ejot nylon anchors were used per board. The stainless steel pin is driven deep into the anchor, leaving a hollow head which is plugged with insulation to reduce the thermal bridge.

The timber-framed areas consisted of a mixture of oak and softwood studs without infill. The voids between studs were filled with Thermafleece PB20 sheep's wool with depths of 100-180mm. Combinations of 50mm and 100mm thick bats were used to fill the voids fully. Woodfibre was then fixed over the face of the studs using

Ejot timber fixings with a stainless steel head and shank, but a hardened steel driving tip. Some pre-drilling was needed in the oak studs.

A similar approach was used on the roof, using a 52mm Steico 'Universal' board placed over the rafters and secured using 100x25mm oak counter battens with stainless-steel hexagon-headed screws. The insulation also provides a degree of racking strength to the roof, but retains the gentle undulations of the structure. The key to successful insulation is elimination of thermal bridges and air leakage, while allowing for movement and shrinkage. In this case, the main junctions were the eaves and between the brickwork and timber frame.

A band course of render was formed using 15mm thick wood wool board to create a weathering over the timber/brick junction under which an Illbruck Compriband compressible foam strip formed an airtight seal.

At eaves level, the wall insulation boards were terminated against a horizontal plywood plate fixed between each rafter foot. These were painstakingly sealed using a Proclima breathable air tape. Insulation was plugged fully into the eaves to provide continuity between wall and roof.

Completion of the work coincided with SPAB's work on *in situ* U-values (see page 4) and the upgraded walls were tested to confirm their actual U-value in comparison to that calculated. As can be seen from Table 2, the results show a remarkable variation in two adjacent walls – one value exceeded expectations, one was worse. This could be owing to workmanship or cold bridging; conclusions have yet to be reached.

External insulation is a very effective means of upgrading the thermal performance of a building when the opportunity arises, subject to careful selection of materials and correct detailing. Thermal bridging at junctions can result in interstitial condensation, so this approach works best when windows and doors are also being modified or replaced. Understanding the actual U-value of the existing construction will avoid the need for excessive insulation thickness, which SPAB's work is demonstrating.

Further information

¹ From ICE, *Inventory of Carbon & Energy*, Bath University, Jan 2011, Prof. Geoff Hammond and Craig Jones

² BR 443, *BRE conventions for U-value calculations*, 2006

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Related competencies include: T012, T021

Element	Existing U-value To BR 443 ²	Upgraded U-value To BR 443	<i>In situ</i> U-value
Roof <ul style="list-style-type: none"> 100x100mm oak rafters Insulated with 52mm woodfibre over rafters, 100mm Thermafleece PB20 between rafters 	2.00 W/m ² K	0.22 W/m ² K	Not tested
Timber-frame walls <ul style="list-style-type: none"> 100x100mm studs, lime plaster on laths inside, rendered outside Upgraded with 80mm Steico Protect replacing render 100mm Thermafleece PB20 between studs 	1.8 W/m ² K	South wall 0.27 W/m ² K West wall 0.27 W/m ² K	South wall 0.35 W/m ² K West wall 0.19 W/m ² K
Brick walls <ul style="list-style-type: none"> 215mm solid brick, 25mm internal lime plaster, rendered outside Upgraded by removing 30-80mm render and replacing with 60mm Steico Protect 	2.38 W/m ² K	0.40 W/m ² K	Not tested

Table 2 – Comparison of target U-values with actual *in situ* of U-values