# Galway build shows cavity wall has a future

A recently completed project in Spiddal, Co Galway shows that traditional Irish construction methods can blitz the stringent 60% energy reduction target under the latest changes to Part L of the Building Regulations. Featuring a cold raft foundation and cavity walls with a wet-plaster finish, the house is proof that with the right knowhow and technology, traditional construction has a bright future.

**Words: John Hearne**

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When clients Nick & Bridie Cooke first approached renowned green architect David Heffernan in Galway, by their own admission they knew nothing whatsoever about sustainable building methods. "I'm a traditionalist," says Nick Cooke. "I like a good solid block built house – I wasn't keen on timber." The Cookes nonetheless agreed to specify both a timber frame and a block built structure when putting the project out to tender. But as the bids came in, all five builders returned costings which put the block built alternative between 5 and 6% cheaper than timber frame. The simple reason is that the cost of laying blocks is now substantially cheaper than it was during the boom.

But to achieve a highly insulated building envelope, the traditional 100mm cavity wasn't going to work. In Spiddal, the design team were able to specify a 250mm cavity, thanks to the Ancon TeploTie wall tie. In addition to facilitating a much wider cavity, the tie is made from basalt fibres, giving it a very low thermal conductivity and dramatically reducing any thermal bridging between inner and outer leaf. On completion, the cavity was pumped with platinum bead.

The wider cavity had a knock-on effect on other elements of the build. Michael Rice of Heffernan & Associates explains that the combination of timber frame with a warm raft foundation has become a common building method in low energy construction. An insulated, reinforced concrete ring beam provides the support on which the frame rests. But because of the width of the cavity, two ring beams would have been required

Photos: Heffernan & Associates/GreenTec Eco Homes

in Spiddal, an alternative that would have driven the cost of the project unacceptably high. Instead, a traditional raft foundation was specified, and low thermal conductivity blocks – Quinn Lite blocks – were used in the first course to reduce the thermal bridge, along with careful insulation detailing at this point. 50mm of Xtratherm insulation was applied on the upstand internally, with mushroom fixed Xtratherm insulation in the cavity tapered from 200mm at the foundation to 100mm at the top of the Quinn Lite block – to accommodate the stepped damp proof course – to ensure continuous insulation and reduce thermal bridging at floor and wall junctions. To strengthen the threshold detail at the doors an extra two courses of Quinn Lite was added to the cavity starting from the lower toe of the foundations. This then had 100mm of Xtratherm insulation mushroom fixed to the inner leaf to ensure no thermal looping between the board and the block with a 50mm cavity maintained to the external.

Though concrete blocks are higher embodied energy than timber frame, the building's carbon footprint was mitigated elsewhere by the use of ground granulated blast furnace slag from Ecocem in the raft.

While the house sits under a traditional cut roof, the design team decided to increase the size of the rafter, to give a deeper 225mm rafter zone to pump fill with cellulose, an inexpensive, sustainable insulation made from recycled newspapers. Because the rafters were that bit bigger, they could also be placed further apart, reducing the amount of cold bridging in the roofing structure. Builder Niall Dolan of Green Tec Eco Homes explains that careful detailing at wall plate level allowed the cellulose in the roof to meet the platinum bead within the walls, giving an unbroken thermal envelope. The thermal performance of the roof was also boosted by the fact that the 40mm service cavity was packed with sheep wool insulation. Meanwhile, down at foundation level, the cold raft was insulated using 150mm of Xtratherm T&G polyisocyanurate insulation.

Super-insulation and the elimination of thermal bridging may be possible with traditional construction methods, but achieving the airtightness that is as vital in low energy building isn't quite as straightforward. Blockwork is porous. Airtightness, Dolan explains, comes primarily from the sand and cement plaster finish. All window reveals and floor zones were plastered before the windows were fitted in order to give an unbroken membrane, and to provide good contact for taping. An airtightness membrane is used in the attic, while more than a kilometre of tape was used on all junctions and opes.

"It is a bit more difficult, but if you get the detailing right on a block build, it can perform as well as a timber frame," says Roman Szypura of Clioma House Ltd, who looked after airtightness on the build, using materials from Ecological Building Systems. "With block builds, the airtightness rests a bit more with the plasterer than with the installer."

The budget couldn't stretch to a service cavity on the walls, and because the house is both open plan and one room deep, most of the ▶

(above) The client incorporated green oak beams into the build. Their weight, plus the fact that they passed through walls meant that careful detailing was required to maintain airtightness; (right) the solid wood door, a traditionally weak point in a house, is a sandwich panel of timber and insulation (p46) thermal bridging and airtightness detailing was made more challenging by the building's form and high surface to volume ratio

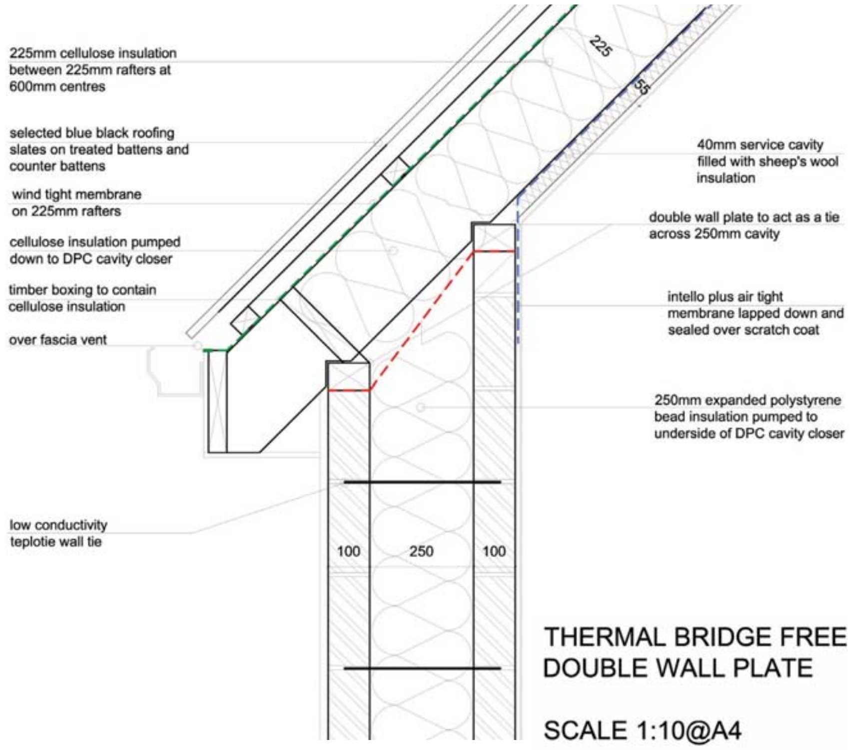
sockets had to go on external walls. Chasing the walls to take the cabling weakened airtightness by making the inner leaf thinner. To reduce air infiltration, Niall Dolan explains that they chased the wall slightly deeper than was required, then plastered the chasing before the electrician arrived. Other issues arose at junctions and a small number of the sockets. Also, a customised rooflight proved particularly leaky and impervious to remedial solutions. But by working through the issues, and through clever detailing at wall plate level, the team were able to achieve an air change rate of 0.78 air changes per hour during pressure testing, only a little shy of the 0.6 required by the Passive House Institute. Heffernan's and GreenTec are currently completing another project using the same spec, and have achieved 0.46 air changes per hour by applying all they'd learned in the Cookes' house.

GreenTec also installed a Renovent HRM heat recovery ventilation system from Brink, an approved member of Éasca, an association set up to promote best practice in sustainable building. Éasca's fingerprints are all over this project – everyone from architects Heffernan's to main contractor GreenTec to suppliers including Ecological Building Systems, Ecocem and Brink have gained Éasca approval.

Yet another Éasca member delivered a sustainable waste water treatment solution – a mechanical wastewater treatment system from BioCycle. The company provided a detailed design package during planning, a free on-site consultation with one of its engineers to plan the install, which was then supervised and certified by one of BioCycle's chartered engineers. All professional services were covered by the company's professional indemnity insurances, and the overall finished system is covered by product liability insurance. Rather than buying an off-the-shelf treatment plant, the Cookes received a bespoke and future-proofed design solution – with the risks borne by indemnified parties.

The system design provided for extended desludging intervals and a high quality of final effluent from the treatment plant. Taking account of the constrained nature of the site, a sand polishing filter and low-pressure distribution system – which has a smaller footprint than a typical soil polishing filter – was installed following the treatment plant. Through working closely with GreenTec, the treatment plant and the low-pressure distribution system overlying the sand filter were installed and certified in one day by a technician and chartered engineer from BioCycle's technical team.

The house itself is built on the footprint of an old stone cottage. Though space is tight, Michael Rice says that achieving the right ori-



entation wasn't a problem. The house is taller and runs deeper into the site than the old house, but it starts at the same line and follows its east/west orientation. "The old house is a gable facing the road, the new house is a gable facing the road. A lot of those very old farmhouses were built facing south, running east to west. That would be the traditional way of building round here." The windows – triple-glazed, argon-filled and of Meranti hardwood – are maximised on the southern façade to optimise solar gains.

Timber frame and roofing specialists A-Frame's Easi-Joist system was used in the project, primarily to maximise internal headroom while keeping the building height in line with planning conditions, and to provide a service zone. While the system worked well, installing it did give rise to delays. In addition, the client incorporated green oak beams into the build. Their weight, plus the fact that they passed through walls meant that careful detailing was required to maintain airtightness.

One other point to make is that the BER assessment, carried out by Hynes Architectural Services, raised an issue with how houses like these are assessed. Under both the 2008 and 2011 building regulations, technical guidance document (TGD) L requires renewables to contribute 10 $kWh/m^2/yr$ to the house's energy requirements in the case of thermal energy (or 4 $kWh/m^2/yr$ of renewable electricity from micro-generation), while in Spiddal, the contribution stands at 8 $kWh/m^2/yr$. This is in spite of the fact that the space heating and hot water in the house come from a combination of Eurotech's Ochsner air source heat pump and a 5kW biomass stove. (- Ed. As Lenny Antonelli explains on pp41-43, falling short of the renewables obligation doesn't necessarily mean non-compliance with Part L, if the house is demonstrably compliant using an alternative method. It would be churlish to argue that this house doesn't comply).

Heat pumps are penalised in Deap – the software used to calculate both BERs and Part L compliance – because of their reliance on electricity. Though the energy intensity of electricity is improving with the addition of more wind and the phasing out of older fossil fuel powered plants, it is still considered a 'dirty' source of power. For this reason, technical guidance document L states that only energy generated by the heat pump in excess of a 2.5 COP can be counted towards the renewables contribution. As the heat pump in this house – which has an excellent COP of 4.21 – is also providing domestic hot water, Deap applies a 25% penalty on the COP where it relates to hot water provision.

The heat pump is fitted with a cost metre – a device which records the kilowatts for day and night separately, adds the two together and calculates the overall rate to work out the total cost. Running costs for November, December and January came in at €26, €31 and €23 respectively.

Michael Rice of Heffernan & Associates says that achieving a low energy build using traditional methods has a number of advantages. "A lot of our clients really like the idea of the solid walls inside and out. And for a lot of builders, it's not a quantum leap for them to adapt to this method. It makes low energy a little more accessible to every builder in that they're using skills that they largely know."

**Architect's statement: Michael Rice, Heffernan & Associates**

The project consists of the replacement of an old stone ruin in Spiddal, Co Galway with a new building of the same footprint.

At the early stages of the project we agreed with our clients to aim for a low energy build ▶

(above) Airtightness plaster behind easi-joists; (above right and below) careful thermal bridging detailing where floor meets external walls; (right) installation of the percolation area for the BioCycle mechanical waste water treatment system; (p47, bottom) triple-glazed argon-filled windows feature heavily on the southern facade to avail of solar gains; (right) ply boxes and stop ends for cellulose insulation, (top) the sheep wool insulated service cavity inside the airtight layer

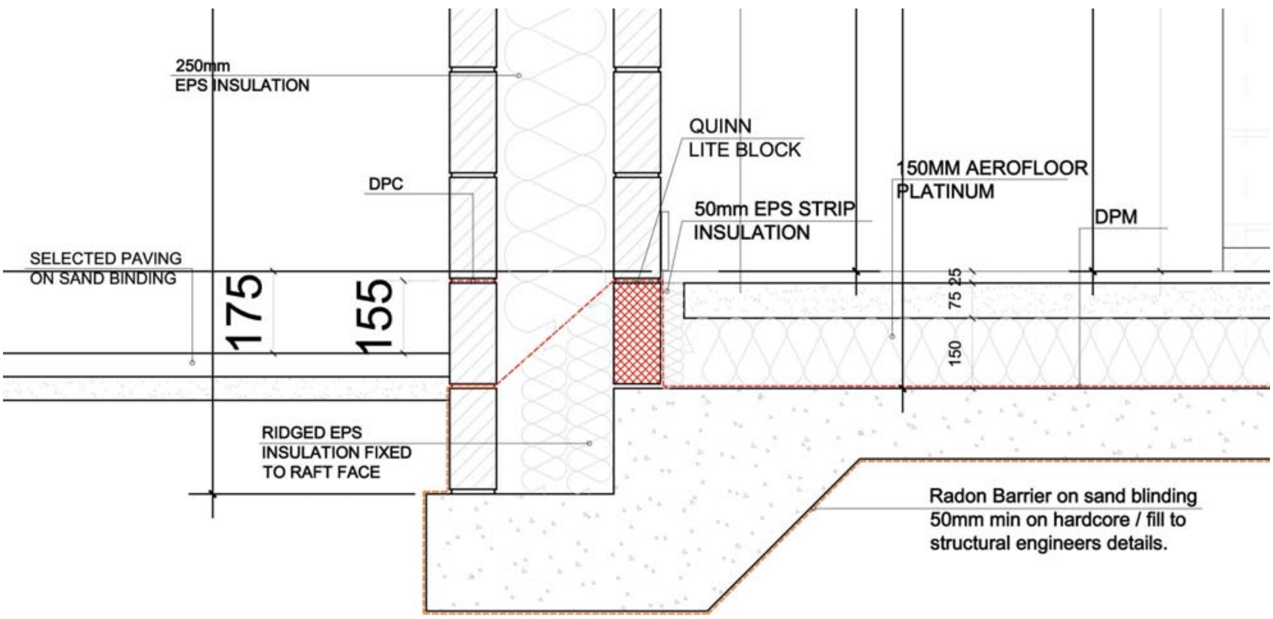
within budget. The aim for us energy-wise was to try and achieve as close as possible to the passive house standard within our clients' budget and brief.

We decided to work up construction drawings in both timber frame and blockwork to the same thermal performance with U-values between 0.12 and 0.14 W/m²K. In order to achieve this with blockwork we used a 250mm cavity – with TeploTie wall ties – pumped with expanded polystyrene bead insulation, giving us a U-value of 0.12. We tendered the house with both forms of construction and found that the timber frame was more expensive by 5-6%. The client understandably chose blockwork. Although this is not ideal from a sustainability perspective it is understandable in the current economic climate. We explored the possibility of using a fully insulated raft. Again unfortunately this proved to be too expensive. So we opted for a conventional raft using Ecocem.

During our detailed design process we were made aware of the very new TeploTie wall tie by structural engineer John Britton which allows for cavities of up to 300mm. Cavity wall construction is the method that Irish house builders and designers are most familiar with and is a method which has been proven over many years to work well in this country. In recent times cavity wall construction has fallen behind timber frame and externally insulated construction methods in terms of thermal performance, however with TeploTie coming on the market it is now possible to achieve super low U-values – as low as 0.12 W/m²K – using traditional cavity wall construction methods without any dry lining, which can cause interstitial condensation.

As well as having a good airtight specification, we used Pro Clima membranes and tapes throughout. It's essential that all details on the airtight line are finalised in advance. The building contractor, Niall Dolan of GreenTec Eco Homes, was experienced and very proactive in solving any possible airtight detail issues.

Window reveals and floor zones were plas- ▶



tered internally in advance of fitting the windows and the Easi Joist first floor to allow for a continuous membrane both internally and externally and also giving good grounds for any necessary tapes. In addition strips of the airtight roofing membrane were put on the top of any stud wall that junction with the airtight line to again allow for continuity of the membrane. Specialist subcontractors Clíoma house Ltd – who have an excellent history of achieving very high levels of airtightness – were brought in to do the taping and to pump the cellulose insulation in the roof. A builder's ability to achieve target airtight levels, proven by blow door tests, is an essential ingredient in any low energy build. The results of the blow door test showed we achieved an airtightness of 0.78 air changes per hour at 50 Pa, very close to our target of 0.6, the passive house standard.

The roof structure is a vaulted 'cut roof' with ridge beam support. We oversized the timber rafters to give us a big 225mm rafter zone to pump fill with cellulose. These bigger rafters could also be spaced at 600 centres, considerably reducing the amount of cold bridging in the roof structure. We specified the Pro Clima airtight system for the roof. An intelligent airtight and wind tight double membrane system, Pro Clima allows you to fully fill the rafter zone with insulation without any risk of interstitial condensation. The cellulose was pumped down into the cavity between the timber rafters and membranes to the slate cavity closer below the wall plate to meet the bead insulation in the cavity wall, giving a continuous thermal envelope at the eaves. In addition to the cellulose insulation in the rafter zone we have a second layer of insulation in the service zone inside the rafters. This 40mm zone was filled with sheep's wool insulation – another natural and sustainable product which, if required, reacts very well to any condensation. A U-value of 0.16 was achieved with this build up reasonably cost effectively. At tender stage, we had a third zone of insulation above the rafters to achieve a super low U-value of 0.12 however this was omitted due to budget requirements.

Windows and external doors – as part of both the buildings envelope and the heating source – are arguably the most important element to any low energy build. It is essential that a build is designed to maximise its exposure to solar gains – it's free heat. For this to work, the windows must collect and help to keep the sun's heat energy in the building. This is achieved with a combination of good orientation and a well-constructed, well fitted triple glazed window. TWD Meranti hardwood triple-glazed windows were selected, with an argon-filled cavity and low-E glass giving a glazing U-value of 0.7 and a whole unit U-value of 1. The solar transmittance or G-value of the glass is 0.64 allowing us to take full advantage of the good orientation. The solid front door, a traditionally weak point in a house, is a sandwich panel of timber and insulation. The windows perform at a level close to passive house windows but within budget. All the roof lights are also triple-glazed to give continuity to the thermal envelope of the building.

For the heat recovery ventilation system – another essential ingredient in a low energy build – we selected a Brink Climate System. Brink specified the Renovent HR which provides a continuous airflow of 100-300M$^3$/h between normal automatic mode and high speed combined with up to 95% heat recovery efficiency through the counter flow sonic welded polystyrol heat exchanger. The system provides a minimum of 0.5 air changes per hour. This combined with the airtightness will provide excellent indoor air quality without any drafts.

The tertiary concern to designing a low energy house, after orientation and the building envelope including airtightness, is the primary heat source. The heating is a less straight forward piece of the jigsaw. Everyone seems to agree that the principles of solar gain combined with good thermal performance and airtightness is a 'no brainer' if you are trying to achieve a low energy building. Where differences in approach tend to exist is in the choice of the active heat source. The reality is all of our clients want heating and hot water on demand year round. The most sustainable way of supplying this demand is with a highly efficient heat pump.

We selected, along with our client Nick and Bridie Cooke, a Eurotech system, which utilises an Ochsner air source heat pump and Eurosmart heat management controls system. The Ochsner is one of the most efficient heat pumps available and when combined with the award winning Eurosmart controls provides a complete heating and hot water solution at very low running costs. The Eurosmart controls also allowed us to take full advantage of any solar gains and gains from the wood burning stove when lit. Cost benefit analysis demonstrates that a heat pump has a relatively long payback period when you are insulating a dwelling to this standard. The investment in the system is significant, but with a guaranteed payback and energy costs continuing to climb steeply it was a case of invest now or pay more later.

The result of the BER – an A2 rating – proves that by using passive design principles we achieved a very low energy and low carbon build, getting close to the current optimal feasible performance, while using conventional Irish building methods and also within our clients' budget and brief.

Selected project details

**Clients:** Nick and Bridie Cooke
**Architects:** Heffernan & Associates
**Consulting engineers:** John Britton Consulting
**Main contractor:** GreenTec Eco Homes
**Quantity surveyors:** Murphy and Associates
**Mechanical contractors:** Western Energy Systems
**Electrical contractors:** F&H Electrical
**Energy consultants:** E.Spellman & Associates Ltd.
**BER assessors:** Hynes Architectural Services
**Airtightness installer:** Clíoma house ltd
**Windows & doors:** True Windows
**Airtightness products:** Ecological Building Systems
**Floor & first course insulation:** Xtratherm
**Thermally broken cavity wall ties:** Ancon
**Thermal blocks:** Quinn-Lite
**Heat pump & heating controls:** Eurotech
**Heat recovery ventilation:** Brink
**Roof lights:** Velux
**Green cement:** Ecocem via Cannon Concrete Products
**Waste Water treatment system:** BioCycle

**PROJECT OVERVIEW:**

**Building type:** 172 sq m 1.5-storey detached house

**Location:** Spiddal, Co Galway

**Completion date:** December 2011

**Budget:** €300,000

**Airtightness:** 0.78 ACH at 50 Pa

**Building Energy Rating:** A2 (46.86kWh/m$^2$/yr)

**Ground floor:** raft foundation insulated with 150mm Xtratherm polyisocyanurate insulation. U-value: 0.12 w/m$^2$k

**Walls:** Sand and cement render on 100mm blockwork with first course of Quinn Lite blocks, 250mm cavity with expanded polystyrene bead insulation and TeploTie wall ties, 100mm blockwork sand, sand and cement plaster with skim finish. U-value: 0.12 W/m$^2$K

**Roof:** Capco natural Spanish roof slates 50x35 battens/counter battens, followed underneath by breathable roofing underlay, 225mm timber joists fully filled with cellulose insulation, Intello airtight membrane, 40mm service cavity insulated with sheep wool, 12.5mm plasterboard ceiling. U-value: 0.16 W/m$^2$K

**Windows:** triple-glazed, argon-filled, Meranti hardwood, overall U-value 1 W/m$^2$K

**Heating system:** Eurotech's Ochsner air source heat pump (COP 4.21 – air 2°c/flow 35°c), underfloor heating throughout with towel rads in all the bathrooms, 300L stainless steel hot water cylinder and 300L buffer tank, Eurosmart heating controls and in addition to the central heating there is a 5kW stove.

**Ventilation:** Brink-Renovent HR, temperature efficiency 95%

**Green credentials:** cellulose insulation, sheep wool insulation, Osmo natural oil used extensively on internal joinery, 50% eco cement raft foundation, locally sourced natural stone boundary walls and chimney breast, reclaimed natural stone chimney lintel, natural slate roof, natural stone kitchen worktops locally sourced.