Greendale studio

A Passivhaus light industrial unit in Canterbury

Most artists' studios are quite modest affairs, but if you are an artist of international repute, creating works of up to 6m x 3m on aircraft grade aluminium frames, you need something on a grander scale. In this article we bring you the project from the perspective of the designer and the contractor.

South elevation of the finished studio.

Designer perspective - Paul Mallion

Nigel Cooke, an artist based in Canterbury, needed a spacious and light studio capable of hanging multiple works on the walls simultaneously with minimum headroom of 3.6m. Nigel's wife Joanne, an architect, designed and planned the new studio. They were determined that the building would be highly sustainable and achieve the Passivhaus standard. Conker Conservation was appointed to undertake the detailed design, building regulations application and give advice on the Passivhaus aspect.

Canterbury City Council classified the locality as a special landscape area, due to its proximity to the ancient Blean Woods. This placed a strong emphasis on the use of traditional materials and modest scale developments. The final design of the studio is along the lines of an agricultural building under a clay tile pitched roof, with weather-boarding. The Council were genuinely interested in the Passivhaus (PH) principles and entered into discussion with us about substituting its standard BREEAM requirement on all industrial/commercial projects. We agreed a condition that would ensure we strived to meet the PH standard, or as close as was practicable. Planning consent was granted on 17 September 2009. Conker Conservation then took the client's design to building regulations, ran the PHPP calculations, and submitted details for Passivhaus certification. Quotes were obtained for PH certification and Peter Warm of Warm Associates was appointed.

Working through PHPP revealed that the building had a large surface area to treated floor area (TFA) ratio. This required very high U-values in the envelope to get close to the specific heating demand value of 15kWh/m²annum. I put this query on the AECB forum and was amazed with the flurry of helpful comments and suggestions. Tiny increases in floor area had a significant effect on the outcome. Peter Warm describes this as the 'heat loss form factor' (HLFF), being the 'heat loss area' divided by 'treated floor area' using PH rules. Peter's rule of thumb for 'form factor' is as follows:

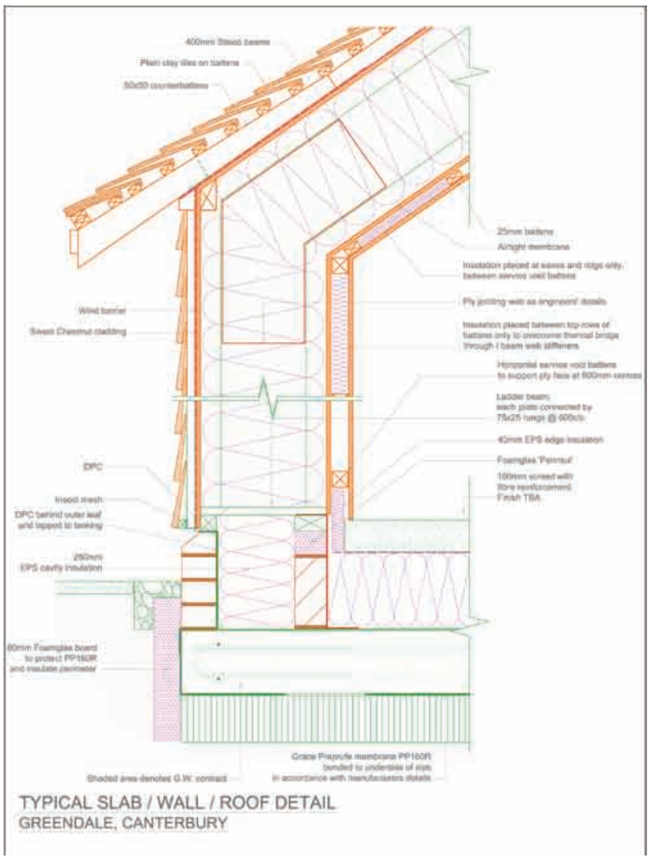
- HLFF of 2, requires U-values of >0.15W/m²K<
- HLFF of 3, requires U-values of >0.1W/m²K<
- HLFF of 4, requires U-values better than 0.1W/m²K, if PH standard can be met at all.

Greendale's form factor was in the region of 3.8 due to the very high headroom typical in an industrial unit. As certification in the UK was still in its infancy at the commencement of the job, we stumbled across a number of problems that have now been resolved. Warmcel's insulation value was being de-rated to 0.04W/m²K at the time, PHI require a 5% safety margin on all products not tested to DIN standards, reducing the value to 0.042W/m²K. This would have required walls over 600mm thick. The alternatives were Knauf Perimeter Plus and Isover Walltherm. Knauf was selected on the basis of available installers and was injected at a density of 30kg/m³, to achieve a k value of 0.035W/m²K, when including the safety margin.

An I-joist timber frame was chosen early on, due to speed of erection and difficultly of access for heavy deliveries. Our experience with I-joists is that they can be difficult to insulate in the corners, and often suffer more thermal bridging than envisaged. We worked closely with the structural engineer, S.C Green Ltd, who also listened carefully to the client's request for an open roof with tie beams/collars as high as possible. Steve Green exceeded all our expectations by producing a portal frame with no ties, relying instead on precision cut gussets to join the wall and roof studs set into the webs, plus the stiffening effect of OSB inside and out. The stud spacing was critical, which posed a difficulty when trying to size suitable rooflights to achieve the daylight targets.

Ventilation

Fume extract ventilation was a critical part of the design. The specialist contractor, MEL (Dust & Fume Control) Ltd, was on board from the outset. The extract volumes necessary when using certain paints with high VOC's created very high energy consumption, and precluded the use of PH certified equipment. Separate MVHR and fume systems were explored, but this led to excessive costs, too many openings through the envelope, and duplicated ductwork. This caused a long delay, whilst various options were reviewed and costed. The process highlighted the difficulty of obtaining all the details required for PH approval, even from a company such as Paul Wärmerückgewinnung, who have certified products.



Peter Warm, as the PH certifier, was keen that we explored more energy efficient options for the ventilation. We felt that fume extraction was outside PH requirements, being an industrial process, but this is still a grey area. Eventually the client decided to review the artists' products he uses, which even with fume extraction, could be hazardous to health. This resulted in a reduced demand on the extract system, allowing a smaller, more efficient and cheaper MVHR system; the Paul 'Maxi 1201 DC'. Ductwork has been left exposed at high level, enclosed at low level.

Heating

There are three separate uses on the site - the new studio and an existing bungalow/office with self contained flat. It was decided to use a wood pellet boiler running via a heat main to serve all three uses. A local wood stove specialist and Windhager installer, Instant Chimneys Ltd, recommended the BioWIN 15kW unit with automatic feed. Within the studio a CaloWIN 1000 litre thermal store is located in the plant room, which is also fed by 5.4m² flat plate solar collector. Hot water is provided by a flash coil in the cylinder. The store also feeds a heater battery in the MVHR, and runs a low density underfloor heating circuit which was installed specifically to ensure the client did not get cold feet, in both senses! Services consultant, Adam Rawlinson of PCS Consulting Services Ltd, co-ordinated the MVHR, UFH, and the controls and pumps, which proved to be a very complex and challenging task due to the different suppliers, installers, and phasing of works.

Lighting specialist, Mary Rushton-Beales of Lighting Design House, carried out daylight analysis and advised on artificial lighting, estimating energy consumption for typical lighting patterns. There are no PH approved rooflights on the market, but from our research the Fakro FTT with thermal flashings appeared the best available, but sizes are limited due to hinge stresses. Triple glazed windows reduce daylight and solar gain, even with reasonable g values. As a result, more rooflights were needed, although the engineer had to limit these openings for structural reasons. As usual a compromise was made. Daylight factors vary from 1.0 to 5.0.

Windows

As with all Passivhaus buildings, windows were a key factor. At the time Ecoframe Systems in Canterbury, who were also supplying the timber frame, were Internorm agents. This made the numerous meetings to go through details much more manageable. Most of the units are from the PH Varion range. However, there are two notable exceptions: a 900 x 2770mm access door, and a 4200 x 2900mm viewing window. The access door is the maximum height frame available, but could not be insulated to PH standard, except with triple glazing, which would push the weight considerably over the maximum permissible. We therefore bought the leaf and frame without any infil. The main contractor, Eco-librium Solutions Ltd, fabricated an infill to my specification using 60mm phenolic foam sandwiched between ply, with a powder coated aluminium facing, giving a U-value of 0.35W/m²K.

Windows were fitted by Ecoframe Systems, but made airtight by the main contractor. An external insulated rebate was used to reduce heat loss from all windows. Due to the unusual design of the building, the solar gain is limited. Windows are quite small and located away from the main studio where wall space is needed for hanging works. A retractable external venetian blind is used to shade the large viewing window, internal electric blinds serve the rooflights.

Being a lightweight timber frame we were concerned about the lack of thermal mass. Internal walls needed to be clad in ply for hanging works, leaving only the 100mm floor screed over the insulation as thermal mass. We therefore proposed a rammed chalk mass wall at one end of the studio. Rowland Keable of Ramcast CIC trained the main contractor who, in turn, obtained agricultural grade chalk locally and carried out the work.

Conclusion

From a detailed design point of view this project demonstrated how much we still need to learn about the nuances of PH design; obtaining sufficient information to satisfy the certifying body, down rating products that we have been familiar with because they lack DIN approval; finding PH rooflights and industrial scale doors and ventilation systems. The 'heat loss form factor' is of key importance, but above all I have to commend the client for staying true to the principles of the project, even when the going was very tough.

Paul Mallion

The main contractor's perspective - Andrew Bassant

Eco-librium Solutions were selected by the client to be main contractor because of our previous experience on several low energy buildings, including one previously certified domestic Passivhaus.

Although designated as 'main contractor', the project was slightly unusual in that significant packages of work were sub-let directly by the client, including groundworks, timber frame structure, external doors and windows, ventilation and renewables. Our principle responsibilities were the chalk wall, internal and external build ups and finishes, electrical installation, plumbing installations and internal fit out. Strategically, the client and designer team were looking to us to provide attendance on the other specialist contractors and to make sure that all the other elements remained 'joined up' through to completion.

As far as Passivhaus certification was concerned it was clear that our preeminent responsibility would be achievement of the rigorous air tightness standards required. Having previously completed a number of buildings to low levels of air permeability we were confident that 0.6 ACH would be achievable if the correct strategy

The portal frame installation went smoothly and the open interior design made it simpler for the contractors to achieve airtightness.
Photo by Cooke Industries Ltd.

were adopted.

To begin with, we made the decision that we would take sole responsibility for air-tightness, irrespective of whether the specialist contractors would normally carry out elements of the work. For example, taping and sealing of external doors and windows was carried out by Eco-librium, rather than the window installer.

In general, the open internal design of the portal frame gave us an excellent opportunity to carry out the air-tightness procedures in one concise operation rather than in the fragmented way that can often occur. We requested that the internal partitions and mezzanine floor structure be installed after our air-tightness installation which the portal frame design facilitated perfectly. Incidentally, it also allowed us to construct the rammed chalk wall inside a fully weather tight structure, with a large covered working space to store and process the raw material. This completely removed the need to provide temporary weather protection or to be concerned about damage to the wall during construction of the timber frame.

Sub floor insulation comprised a double layer of phenolic insulation, with all joints taped. The internal wall surface was OSB with taped joints, while the plinth blockwork was covered by a polythene vapour check bridging across from the OSB to the sub floor insulation. Thereby addressing that problematic floor/wall intersection. The calculations showed that a vapour check was required to the underside of the roof.

First fix plumbing and electrics then followed which allowed all penetrations through the air-tight layer to be dealt with at one time. A preliminary air test was then carried out before any finishes or further build ups had been installed. Happily, the average result of compression and decompression testing was 0.4 ACH, with the decompression test being particularly useful for locating leakage. One or two cable penetrations required further attention but, in general, it was difficult to find air movement event at 53.2 pascals depressurization.

We then had the confidence to proceed with finishes knowing that as long as any future penetrations were controlled we should achieve the target. In fact only two additional penetrations were made, which were carefully dealt with at the time.

Conclusion

Apart from the complications of the various mechanical and electrical installations which have been referred to above, the project was not technically challenging as far as Passivhaus responsibilities were concerned. We would certainly recommend designing structures to be as open internally as possible and to adopt a clear airtightness strategy, including a preliminary test at a key point prior to covering up.

Andrew Bassant

Paul Mallion is a co-director of Conker Conservation Ltd, chartered building surveyors, a family business based in Canterbury Kent. After completing a part time degree in surveying, Paul went on to complete a MSc. in architecture (environmental design and engineering) at University College London in 1995. Conker Conservation Ltd was established in 1999 with his wife Angela, also a chartered building surveyor. The aim of the company, from the outset, was to design sustainable and energy efficient buildings.
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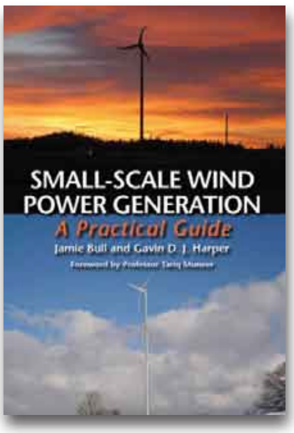
Book review

Small Scale Wind Power Generation

For those wishing to find an introductory technical primer to the subject, Small Scale Wind covers all of the basics of the technology of small wind turbines. The book covers the basic theory; from the basic aerodynamics required to understand turbine operation, to the electrical theory behind electricity generation - but does this in such a way that theory is linked to current practice. There is also a detailed coverage of the science behind the 'wind resource' itself.

All of the basics are covered well, with just about everything you would expect to see in a book on this subject; outlining the civil and electrical engineering works required to install a turbine.
The book is in full colour and heavily illustrated with many diagrams and pictures supporting the text. Perhaps the only failure of the book is that it attempts to include data from a range of popular turbines that are on the market ,which is likely to date the book very quickly. Perhaps This would have been better been aproached in a partner website or similar updatable link.

What is nice though is that it is written with a UK audience in mind; containing information that is likely to appeal to the UK reader. The book contains detailed information which is useful to conduct an economic appraisal of small scale wind projects - but goes further than this, by giving an explanation as to methodologies which can be used to appraise the carbon savings from a turbine.



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