Passive learning

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Tony Godwin describes the process of building his home tothe Passivhaus standard

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It is now 15 months since we moved into our Passivhaus.Humidity and warmth are consistent, to the extent that you cannot believe howcold it is when you go outside. The mechanical ventilation heat recovery (MVHR)system quietly rids the house of lingering smells and excess water vapour,meaning that our laundry dries overnight, if not sooner.

Figure 1: Rutland Passivhaus south-west elevation

The designed temperature of 20?C does not feel cold becausethe limiting values ? including a requirement to be 12 times more airtight thanUKBuilding Regulations Part L ? ensure that thermal comfort is maintained,and you can sit right by the windows without feeling cold.

Proven methodology

Passivhaus is a methodology for achieving very low-energybuildings in all climates. There is also a standard for retrofitting with less stringentheating demand and airtightness targets, and two for nearly zero-energybuildings that factor in renewable energy generation (see Hitting the target).

Passivhaus is not a prescriptive construction method, butthe heating demand of 15kWh/m2 /year and the limiting values make airtightnessand thermal bridging far more critical than they are in UK BuildingRegulations. Although they should be well within the capability of constructionworkers to achieve, the standard still involves some unfamiliar techniques andmaterials that require planning, care and teamwork.

Designing for the Passivhaus basics from the outset isessential, and buildings should be orientated and glazed to enable solar heatgain. Architects ought to be able to use the Passivhaus Planning Package(PHPP) with a sketchUP plug-in for 3D modelling to assess early concepts; but I would still recommendusing an experienced Passivhaus designer because data input is critical forcertification, and experts can help with detailing. The Passivhaus Trust , the UKaffiliate of the InternationalPassivhaus Association , is a helpful resource, and its annual conferenceprovides a great opportunity to engage with other practitioners.

Surprisingly, the UK has 22 different climate datasets,among which the East Midlands ? where our home is built ? is one of thecoldest. Our first PHPP iteration predicted a heating demand of 22kWh/m2/yearbecause its ?T? shape with single-storey sections and a garage under the firstfloor resulted in a high ratio of external surfaces to floor area, and therewas also a greater proportion of glazing to the north. The redesign, featuringimproved U-values and envelope thicknesses up to 600mm, required a new planningpermission.

Fabric

With the lower floor of the house built into the slope ofthe site, the external envelope had to have detailing for above- andbelow-ground conditions, maintaining continuity of waterproofing, insulationand airtightness.

The solution comprises a 300mm double-stud structural timberframe filled with Warmcel ? blownrecycled newsprint that fills the voids around the studs ? set on a groundbearing slab in front of the reinforced concrete retaining wall.

Figure 2: Timber frame in progress: living, dining, kitchenspace with bedroom wing beyond

The slab sits on a minimum of 200mm high-compressionexpanded polystyrene (EPS) over a damp-proof membrane, joined to aself-adhesive tanking membrane applied to the retaining wall. The wall isinsulated externally with EPS, protected by a composite plastic drainagemembrane and geotextile.

This arrangement exposes the concrete slab internally, withits mass providing thermal storage that delays the effect of externaltemperature fluctuations and also reduces the resultant energy requirement,keeping the insulation dry for thermal performance as well.

The timber frame is lined internally with a Durelis vapour-proof oriented-strand board that acts as the airtight layer, and theplasterboard is battened off this to provide a 37mm zone for services. A mineralwool ?overcoat? is then fixed externally in the cavity behind the variouscladding types, providing continuity with the EPS below ground.

Energy, heating and ventilation

The high level of airtightness makes an MVHR system anintegral part of a Passivhaus. The ductwork has to be designed and integratedinto the building at an early stage. The air extracted from the bathroom, thekitchen and the utility room, where the plant is located, warms the 100%fresh-air input to all other rooms via the heat exchanger, changing the airaround every three hours. A gap under the internal doors provides a route forreturning air.

Heating and hot water is provided by a small gas boiler servinga wet system circuit with three strategically placed radiators, three heatedtowel rails and a 110-litre hot-water storage cylinder. The choice of gas as anenergy source was entirely pragmatic, providing low capital and running costswith familiar technology. We also have a 1.8kW solar thermal panel and a 3.5kWsolar photovoltaic array.

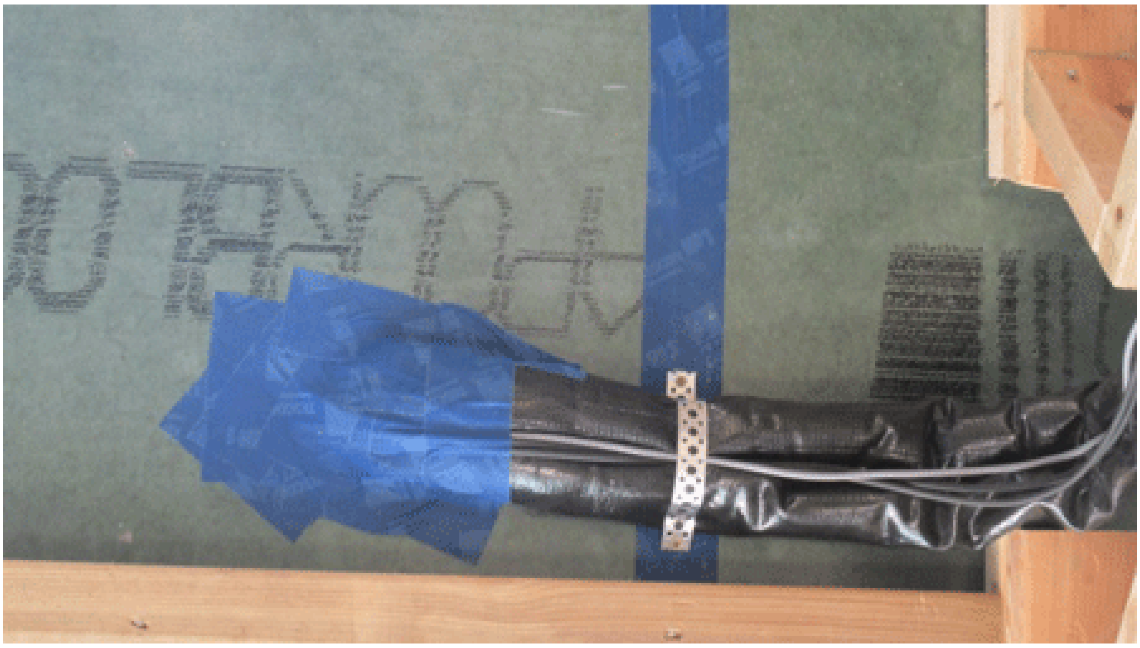

Figure 3: A bunch of services ? here pre-insulated solarthermal pipes with sensor cables ? passing through the airtight layer aredifficult to seal

Construction, procurement and cost

The project team was vital to the project?s success,remaining open-minded and collaborative on unfamiliar territory; but only previousexperience could have prepared us for the critical role of airtightnessdetailing. We air-tested on completion of the airtight layer ? an essentialprocess ? and carried out two further tests, with many person-hours spentfinding and rectifying leaks before achieving the required value of 0.6 airchanges per hour (measured at 50Pa pressure).

A schedule of all service penetrations should be preparedand agreed by the mechanical and electrical contractors, and appropriatelysized airtight grommets purchased. Proposed substitution of specified insulationmaterial must be reported and agreed; in our case, the mineral wool in the roofwas built up in layers of different thicknesses with different lambda valuesand the contractor varied these, resulting in a loss of U-value.

Figure 4: Expanded polystyrene insulation and tanking at thebase of the retaining wall

In selecting contractors and suppliers, we prioritised thosein a 30-mile radius of the site for the sake of sustainability, and avoidednominating subcontractors so that the main contractor would remain responsiblefor all aspects of the project, except for unfamiliar items critical to thePassivhaus standard. We only sourced imported items though UK distributors,which we assessed for reliable support infrastructure.

Prices obtained for the timber frame during the design stagerevealed an apparent premium for manufacturer?s systems developed forsuperinsulation and airtightness, which led us to make this a domestic subcontract.However, the lack of understanding of Passivhaus and the inflexibility of the manufacturer?ssystem, which was designed to meet UK regulations only, created constructiondifficulties that probably outweighed the savings we made.

Procuring windows that were triple-glazed from themanufacturer Katzbeck in Austria was alengthy process due to indirect communication through the UK installationrepresentative. In future, I would always make time to visit the manufacturer.

Note that tilt or lift-and-slide windows are difficult tomake totally airtight due to the mechanisms involved; we have two in our livingarea, and it is noticeably cooler on really windy winter days.

For the sake of certainty, I chose a Passivhaus-certified Paul MVHR system, designed andsupplied by the Green BuildingStore , and would still look no further.

We have calculated the additional construction cost formeeting the Passivhaus standard to be 25.6%, which is based on median BCISrates for constructing the building on a flat site to current BuildingRegulations.

A report in 2015 commissioned by the Passivhaus Trust concluded that costs were 10?20%more than for achieving Level 4 of the government?s now abandoned Code for SustainableHomes. However, these figures do not consider lifetime costs, nor do they valuethe extra quality and our increased comfort and health.

Performance

There is no doubt that the building performs in line withexpectations. Visitors always comment on how warm the house is, and our energyusage is well within the limit of the Passivhaus criteria.

Our energy bill for the past year was ?900 or ?4/m2.To put this into perspective, the 2004 Wimpey-constructed house that we rentedduring construction ? a compact 7.8m x 7.8m on two storeys ? cost ?18/m2,which is equivalent to ?4,185 for the same area as our Passivhaus.

Heat is only required in our new home when the externaltemperature falls to 7?C, and when we are indoors, it is better to leave theheating on and control it by the remote digital thermostat. This is generallyleft in the living area, but we do move it with us into the bedroom on coldernights due to the temperature differential. While this was expected, becausethe bedroom has a higher proportion of external envelope than other parts ofthe house, the differential is never more than 2?C.

Our studio is heated nicely by ourselves and by our officeequipment during the day. Humidity varies little from a level of 60%, andmaximum summer temperature indoors is 25?C.

As one of our visitors during an InternationalPassivhaus Open Day exclaimed: ?Why would anyone not want to build aPassivhaus??

Tony Godwin is an architect at FCD Architecture

Further information

- Passipedia ? The PassiveHouse Resource
- Images ? Tony Godwin
- Related competencies include ConstructionTechnology and Environmental services , Legal/Regulatorycompliance , Planning and Sustainability
- This feature is taken from the RICS *Buildingcontrol journal* (June/July2016)