Passivhaus schools

ACHIEVING PASSIVHAUS IN THE UK: *THE REALITY*

Architype has been specifically promoting Passivhaus and designing to its technical standards for over four years, and in October 2011 it handed over its first major Passivhaus projects – two new schools in Wolverhampton, Oakmeadow primary school and Bushbury Hill primary school. In this article, Architype Director, Jonathan Hines outlines how the experience of delivering these schools has enabled the practice to understand the challenges... and experience the reality of achieving Passivhaus in the UK.

Establishing that Passivhaus was the right standard to champion

For Architype, Passivhaus seemed to offer a logical progression of the 'eco-minimalist' approach to design that we have been pursuing for 27 years. Our focus has always been on reducing energy consumption by good design, rather than offseting carbon with micro-renewables or relying on other 'techno-fixes' or 'eco-cliches'.

However, we were initially sceptical of a number of aspects of Passivhaus, for example the requirement to use mechanical ventilation with heat recovery. We began thorough investigations, attending the annual International Passivhaus Conference in Germany, visiting Passivhaus projects, and talking to European Passivhaus designers and fellow pioneers in the UK.

We gradually began to realise that Passivhaus is simply a quality standard that guarantees performance. Its true value rests upon the assurance that its performance claims are both credible and reflect a genuine benefit to both the user and the environment, including:

- Minimised energy consumption;
- Avoidance of building defects that can lead to mould growth;
- Excellent standards of thermal comfort (satisfying ASHRAE55 and complying with EN7730);
- Minimised energy bills;
- High standards of indoor air quality;
- Optimised lifecycle costs.

We became convinced by the intensive monitoring of Passivhaus buildings over 20 years, which has demonstrated the validated quality-assurance requirements of the standard, in contrast to much of the current monitoring of buildings in the UK which is showing consumption way above that which was predicted.

Demonstrating to clients that Passivhaus is the best option

Next we had to demonstrate to clients that adopting Passivhaus was the best option – and that we could achieve it at no extra cost to them. We have found that the main barriers to persuading clients to adopt Passivhaus include:

THAT BREEAM & CODE FOR SUSTAINABLE HOMES ARE THE ESTABLISHED VALID UK STANDARDS

We explain that Passivhaus and UK standards such as Building Regulations, Code for Sustainable Homes and BREEAM were developed for different purposes and consequently have fundamentally different aims. UK standards were designed to meet 'top down' political aspirations – currently a broad range of environmental issues, including water and waste, but most significantly 'zero-carbon' targets.

Passivhaus was developed from the 'bottom up' by building physicists seeking effective ways to design low-energy buildings and ensure that they perform as predicted, in response to evidence that they were not. Instead of seeking to score wide-ranging environmental and carbon targets, Passivhaus sets a rigorous energy target.

We have found that the tangible benefits of Passivhaus – optimum internal comfort for the lowest possible energy consumption are easily understood by clients.

THE MYTHS

It is relatively easy to dispel the myths – we explain that you *CAN* open windows, that Passivhaus *IS* valid in countries outside of Germany, and that in German 'haus' means 'building' not just 'house' and that Passivhaus is equally valid to *ALL* buildings types.

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COSTS

Initially we demonstrated that if Passivhaus does cost 10% more, then the payback is within 5 to 10 years, which is faster than renewables. However, we also realised early on that the real challenge is to achieve Passivhaus at no extra cost.

When Architype proposed Passivhaus to Wolverhampton City Council they enthusiastically endorsed it, being for them a relatively small step on from the approach that they had seen succeeding in other Architype projects. Architype has worked with the Council since 2006 on a progression of projects, including the award-winning St Luke's Primary School. However their budget was fixed to that allocated for a normal standard primary school and the proviso that it should not affect their tight programme or their fixed standard budget.

Bushbury Hill Primary School, Wolverhampton

Solving the technical demands

No-one should underestimate the biggest challenge – solving the technical demands of achieving Passivhaus. It is easy to be lulled into assuming that meeting some of the standards such as U-values is sufficient. Passivhaus requires a complete change in thinking about design and construction.

The Passivhaus Planning Package (PHPP) must be understood and used from day one as a design tool to drive the design. Passivhaus must be integrated into design thinking from the outset, influencing form, orientation, building fabric and construction detailing. A collaborative and integrated approach to design and construction is essential at every stage. The design of Oakmeadow and Bushbury Hill Schools demonstrate how we responded to these challenges:

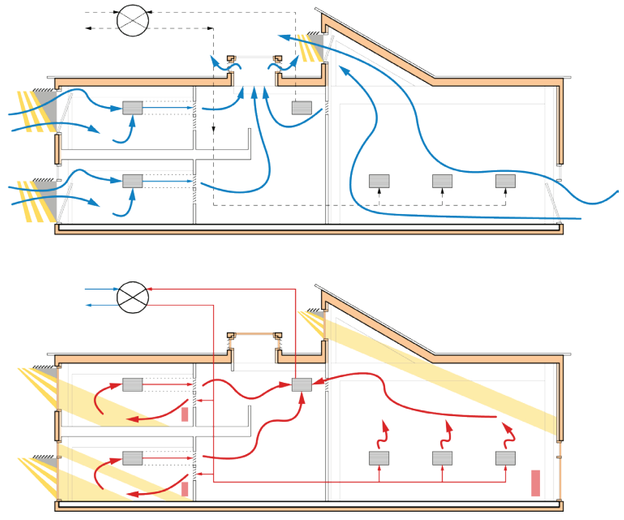
FORM AND ORIENTATION

We tested and retested ideas, looking at different orientations and options of single and two storey. It became clear that optimising the ratio of internal floor area to external surface area was critical in minimising heat loss, and we opted for largely two-storey forms orientated with all principal rooms facing north or south, to enable maximum useful solar gain with effective control of overheating and good daylighting.

ELIMINATING THERMAL BRIDGES

Thermal bridges are all too common in standard UK constructions – junctions at wall and foundations, at window heads and jambs, at wall and roof, together with project structures for roof overhangs or balconies. We focussed rigorously on systematically eliminating these.

The construction approach is based on previous projects (lightweight well-insulated timber frame), but went a step further; to reduce thermal bridging and achieve Passivhaus airtightness we used a simplified loadbearing stud wall (instead of structural I-beam) which is wrapped by an additional 'duvet' layer of insulation created by Larson trusses.



We eliminated all structural penetrations of the thermal envelope, with roof overhangs and canopies constructed outside of the thermal envelope, and any elements of loadbearing structure contained inside the thermal envelope.

The foundations were rethought completely to create a fully insulated concrete slab, floating on rigid insulation, which returns at the edges to meet the duvet layer in the wall.

ACHIEVING THE RIGOROUS AIRTIGHTNESS STANDARD

UK building regulations set a standard of 10 airchanges per hour under test at 50 pascals, whereas the Passivhaus target is 0.6. This requires a step change in thinking about detailing and in approach to construction.

We rigorously worked and reworked every detail, eliminating complex junctions and seeking the most logical, simple and buildable solutions.

These were discussed and developed in close collaboration with our Passivhaus consultant, Nick Grant, and the contractor, Thomas Vale Construction.

We held workshops involving key site staff and subcontractors (timber frame, windows and airtightness tape sub-contractors), to boost everyone's understanding of airtightness and develop a spirit of collaboration. Thomas Vale reprogrammed its sequence of work, to achieve a tested airtight shell, prior to proceeding with first and second fix. The result was compliant and satisfying – 0.48, significantly below the requirement of 0.6, and a 95% improvement on UK building regulations.

SERVICES STRATEGY

The services strategy is developed to integrate centralised full MVHR for winter operation, combined with natural passive ventilation for summer day ventilation and night cooling. Heating is by means of simple thermostatically controlled radiators supplied by small gas boilers which provide controllable top-up heat, although for most of the school day the heat of occupants reclaimed by the MVHR is sufficient to maintain comfortable temperatures.

WINDOWS AND DOORS

Particular attention was given to the design of windows and doors to balance the additional costs of the required 0.8 U-values, and achieve the required daylighting and levels of ventilation. We opted for a curtain walling system with simplified and optimised openings.

PRIMARY ENERGY

In contrast to UK regulations, PHPP takes into account all energy consumption including the 'unregulated' (IT, other equipment and fittings). A key challenge has been addressing the energy consumption of the schools' IT equipment. The schools' kitchens created an added pressure as most German schools do not have catering facilities.

We held workshops with the Council's IT officers and the catering staff and were able to persuade them to opt for electric induction cooking, which is not only more efficient but significantly reduces the need for energy wasteful extract ventilation. Early feedback shows that the catering staff are delighted with the speed of induction cooking and the increased comfort and lower temperature of their new kitchens.

Cultivating the collaborative approach required to deliver Passivhaus on site

Architype has developed a collaborative relationship with Thomas Vale Construction over many years of delivering innovative projects together. The trust and shared understanding that we have developed was fundamental to turning Passivhaus design into constructed reality. Integrated design and collaborative working is the key to delivering higher standards of construction.

Dealing with the certification process

We have found the certification process to be demanding and rigorous. It is essential to commence early with putting together the technical evidence required which includes the PHPP, design and detailing information, thermal bridge calculations, evidence of construction including supply of key materials, air tests and commissioning data, and detailed calculation of primary energy.

Together Architype, our design team and Thomas Vale Construction have achieved Passivhaus at no extra cost. We are now supporting users through a Soft Landings process and are beginning the monitoring of the buildings' performance.

Oakmeadow Primary School, Wolverhampton

Interior Oakmeadow Primary School

Interior Bushbury Hill Primary School