MassivPassiv:

The benefits and challenges of applying Passivhaus to Purpose Built Student Accommodation

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ArchitecturePLB has a long history of sustainable design. It is part of our DNA and a 'long life, loose fit, low energy' approach is one that we take to all of our buildings, whether there is a specific sustainable agenda or not. Having designed a 'Passivhaus' accredited home for a private client in 2013, it became clear that the principles of a fabric-first, comfort-based, climate-led design approach aligned with our own. Since then we have sought to inform all our projects with input from our in-house Passivhaus Designer, Paul Phasey. In 2017 we hosted a 'Green Sky Thinking' event which looked at how Passivhaus Principles could be applied to purpose built student accommodation to create more comfortable, efficient and cost effective buildings, however the parallels with PRS and Build to Rent more conventional forms of high density living are strong.

The Problem

In recent years ArchitecturePLB has worked on a large number of schemes for Purpose Built Student Accommodation (PBSA). Over 9000 rooms have been designed, with 6000 completed and the remaining 3000 either going through planning or under construction.

While the projects are generally successful in townscape terms, we have been frustrated by a consistent performance gap, primarily in terms of overheating. This is not just our own experience but is widely evident across the sector and tends to result from a minimum-compliance approach to the different Building Regulations in isolation, combined with inconsistencies between design and delivery. With some rooms regularly exceeding overheating limits (28˚C for 1% of the time for a BREEAM Excellent Building), we therefore asked ourselves "Would a Passivhaus solution help?"

So what is Passivhaus?

Passivhaus (PH) is an energy standard that focusses on achieving excellent comfort levels for a building's occupants. Although personal perception varies, the principles taken for comfort are: a consistent internal temperature; lack of draughts; good levels of fresh air and minimal overheating. These are achieved by very close attention to detail at the design stage and the ratification of work on site to ensure that the building performs as intended. The aim is to achieve a balance between heat gains and losses, such that the energy required for heating (or cooling in hot climates) is minimal. Originally a domestic standard developed in Germany in 1991, it is now recognised across central and northern Europe and has been applied to all building types and climatic zones.

Achieving PH starts at concept stage. While in theory any design is possible, a simple form with good solar orientation will generate efficiencies later on. These can be enhanced further by grouping dwellings, for example in a terrace or block of flats, thereby minimizing the 'envelope' (the area of external walls, roofs and floors) through which heat is lost. This approach leads to a lower Form to Heat Loss Factor (FHLF - the ratio of the heat loss area - the envelope - to the heated floor area of the building). As you reduce the FHLF, you also reduce the need for additional thermal insulation. (03)

There are a number of misconceptions about Passivhaus buildings, the most common being that occupants can't open the windows. This is fundamentally untrue and, in contrast, cooling by opening windows (either during the night or daytime) is essential in reducing overheating. Secondly, the name Passivhaus implies that it is just for dwellings. Again, this is not the case and the standard has been successfully applied to schools, university buildings, swimming pools and offices.

Most importantly though is the question of whether the standard works. For nearly 30 years, Passivhaus buildings have been built throughout central Europe and many years of monitoring have shown that they have been consistently proven to perform in line with predictions.

Why Student Accommodation?

The problem of the performance gap, particularly in terms of overheating, is becoming a significant issue for providers. We are aware, for example, of cases where universities have had to compensate students for periods when rooms fail to meet acceptable levels of comfort. Although Passivhaus can never eliminate overheating, it can reduce it to manageable levels.

Purpose Built Student Accommodation buildings are generally large, relatively simple forms with repetitive details. They therefore tend to have an excellent FHLF which, combined with high internal heat gains, means that they should need little, if any, additional thermal insulation.

They are also a long-term investment for their owners or funders. While Passivhaus may increase the initial construction costs, the additional investment can pay dividends through the life of the building, from low heating bills to reduced maintenance and fewer complaints. For an operator charging rent inclusive of bills, this may mean greater returns. For a university, it can also significantly contribute to CO^2 reduction targets.

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01 First Passivhaus home in Hampshire designed by ArchitecturePLB in 2013

02 Stapleton House, Purpose Built Student Accommodation Scheme in Islington, completed in 2016

03 Form Heat Loss Factor: The lower the FHLF the lower the insulation levels for PassivHaus. Hence high-density schemes such as PBSA / PRS, with low FHLF <1 will have U-values similar to current building regulation minimum, however a single house, may have FHLF of >3 making meeting the standard achievable, but potentially with high insulation levels and more costly detailing.

What are the challenges and potential benefits?

To test the application of Passivhaus to PBSA, ArchitecturePLB retrospectively applied its principles to a non-PH built example, our Stapleton House scheme on Holloway Road Completed in 2016 to a BREEAM 'Excellent' rating. The hypothesis suggested that the scale of the building would generate an excellent Form to Heat Loss Factor and therefore 'easy wins' in achieving Passivhaus standards and benefits. This has been borne out by our modelling, which revealed very favourable results and a FHLF of 0.8. We assessed, how the building fabric of Stapleton House could be altered at design stage to ensure it would meet Passivhaus standards:

- Insulation; PH requires excellent insulation, installed with precision with no gaps over 3mm wide. The design's efficient form factor already results in near-building regulation levels of insulation, therefore there would be no cost increase or higher land take from thicker external walls.

- Mechanical ventilation with heat recovery (MVHR); would provide fresh air far in excess of UK Building Regulations, while recycling heat from the outgoing air; Stapleton's cluster arrangement of student rooms with a shared kitchen would allow for a decentralised system, keeping duct sizes small and domestic in nature. The good FHLF would also allow greater flexibility in specification, meaning that cost-effective and readily available units could be used. The additional acoustic and air quality benefits should also not be ignored.

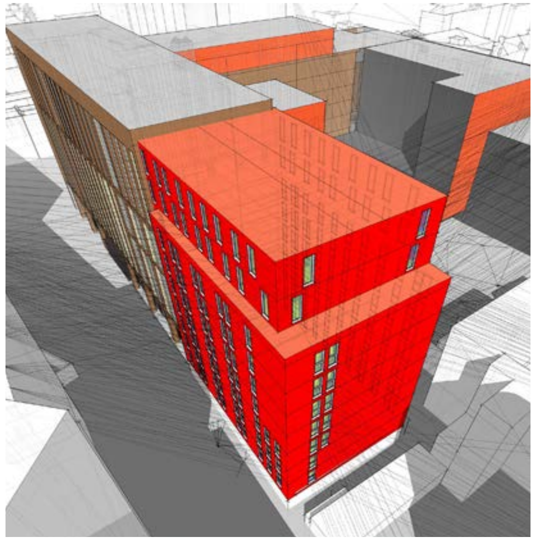
- Airtightness; the simple form of the building means that the most challenging junctions, at ground and roof levels, are minimised. Combined with repetitive detailing, this means that the required airtightness target could be achieved, although attention to detail and construction quality would remain crucial. A possible solution could be an off-site unitised solution which brings wall panels to site factory-finished including windows and internal finishes.

- Thermal bridges; areas such as the junction between two construction elements which are difficult to insulate would need particular attention. Taller buildings require that the façade is effectively hung from the structure and thermal detailing would therefore need to be carefully considered. Student housing typically avoids balconies which are a key weakness of conventional housing projects. Again, the good FHLF would compensate to some degree for less than ideal detailing.

- Windows; probably the most challenging aspect from a design point of view, and for Passivhaus generally. Larger windows are often preferred for aesthetic reasons but can contribute significantly to overheating or heat losses, depending on orientation. Triple glazing is also expensive, though in this instance would be highly repetitive. Again, the excellent FHLF would provide some flexibility in terms of achieving the requisite performance. The window design is probably the key factor and would need to be considered from first principles, including the size of the windows, their orientation and external shading, either from building-mounted 'brise-soleil' or from neighbouring buildings or trees.

In addition to these issues, the internal heat gains from occupants and the hot water distribution system (that can act like a radiator inside the building) would need careful consideration. There are also savings to be had however. In this example no heating system would be required and the renewables provision, required through the planning system, would be significantly reduced or even eliminated.

The final challenge is budget as there is a likely increase in capital cost for Passivhaus. In 2017, Gleeds reported this as an 11-22% uplift, with a payback after 13 years, although this was already 5% less than in 2012. However, Wolverhampton's Wilkinson Primary school recently achieved Passivhaus standards at zero extra cost and Exeter City Council is now delivering PH dwellings within normal budget costs. Furthermore, these figures do not consider the installation and running costs associated with retrofitted cooling, nor do they account for increasing energy costs.



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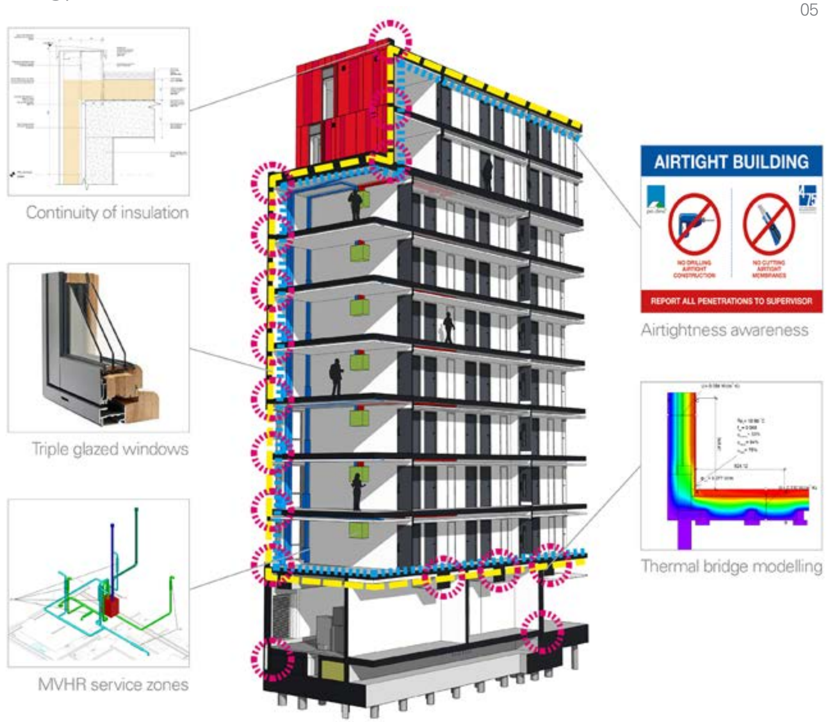

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04 Energy Modelling with Design PH. Used to establish the FHLF and to test design and massing ideas. The modelling shows a FHLF of 0.86 and a Heat Load (Qh) of 8 kWh/m2/yr, the upper limit for PH is 15 kWh/m2/yr.

05 Section highlighting the key components of a PH in the context of Stapleton House.

Conclusion

ArchitecturePLB believes that there is a fundamental compatibility between PBSA / PRS and Passivhaus. The rigour and attention to detail required through the design and construction processes will result in a higher quality building and therefore a more secure investment, while also giving designers the tools to avoid some of the unexpected consequences of less sophisticated modelling. Although unusually hot weather, such as the summer 2018 heat wave, will always result in high internal temperatures, problematic overheating would be minimised, and thus students' perception and experience enhanced.

We must not however lose sight of the impact of a building on its physical, social and historic context, and on its contribution to successful placemaking. To achieve a high-quality design, optimal Passivhaus solutions may need to be tempered, using enhanced construction technologies to offset non PH-ideal design features. In contrast, good PH design may itself result in visual interest and richness, for example through the use of deep reveals, overhangs or other shading devices.

Good architecture always responds positively in balancing the competing demands placed on a building, including urban design, environmental performance and functional requirements. Our challenge is to negotiate and reconcile these demands to create not just good, but intelligent architecture.

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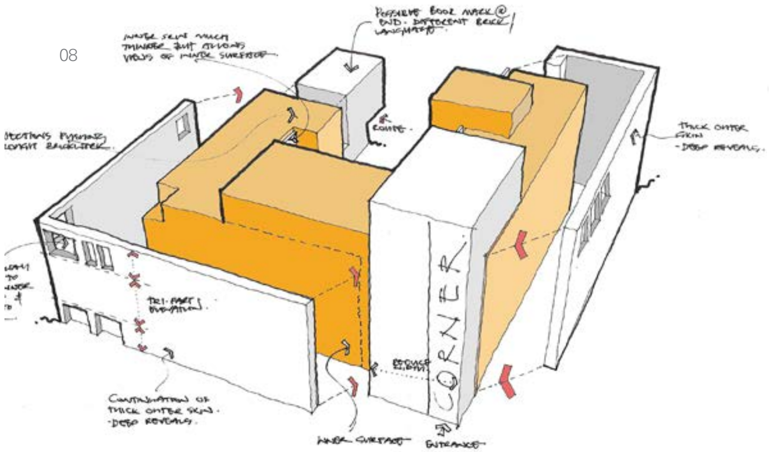

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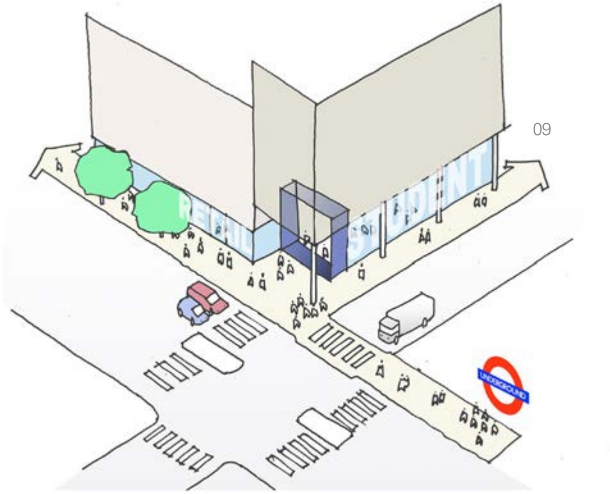

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06 The design team for Stapleton House carefully considered the buildings contribution to the street

07 An internal courtyard provides external amenity space.

08 Sketch massing concept

09 Street level interaction concept

Awards for Stapleton House:
Student Accommodation Awards, Private Halls of Residence [London] of the Year, Winner
Planning Awards 2017, Award for Design Excellence, Shortlisted