Camden Passivhaus, London's First Passivhaus

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Figure1: Camden Passivhaus, south façade

1 Objective

To investigate through practical application, how we could use the PHPP to design, detail and construct an energy efficient home that also meets the specific constraints of a very small and over shadowed site in London.

2 Method

The primary objective of this project was to achieve a comfortable and healthy home for our client, her boyfriend and small pet dog, Twinkle, while minimising energy consumption.

At an early stage in the design process, bere:architects discussed the possibility of designing the house to Passivhaus standards with the clients. The house was designed to maintain warm and comfortable interior temperatures using less than 15kWh/(m^2a) for heating; even during the coldest expected London conditions. This meant that a conventional heating system could be omitted from the design. As our client suffers from asthma, in addition to the incredibly low heating bills she could expect from her new home, she was particularly excited by the prospect of healthy indoor air quality. Based on both the energy and air quality advantages of the Passivhaus model, our client agreed to embrace this exemplar standard and build London's first Passivhaus.

Prior to the ambition of a certified Passivhaus, an initial design (also highly energy conscious) had already been developed (figure 2). As one of the first steps towards achieving the Passivhaus standard, we carried out an in-house model analysis of the initial design using the PHPP.

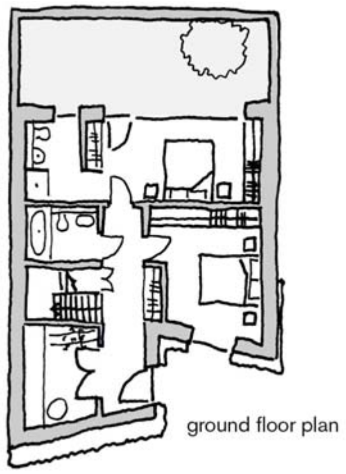

Figure 2: Initial design

This scheme has a high percentage of north glazing. The envelope to treated floor area (TFA) is also fairly high.

Result = 21.2kWh/(m^2a)

This first PHPP analysis showed the initial design achieved a very low heat energy demand of 21.2kWh/(m^2a), however this was not low enough to meet the Passivhaus standard. This meant the house would require a conventional heating system to meet times of peak heat demand. By analysing the data in the PHPP, we established the initial design had too much north glazing for a small house and the ratio of building envelope to volume was also too high, resulting in excessive heat losses.

3 Project Development and Planning

Using the knowledge gained from these first PHPP investigations, bere:architects developed and tested a series of iterations based on the initial design. We analysed each design using the program, however none quite achieved the Passivhaus standard. It was also established that, although supportive in principal of the project, the local planning authority had some reservations about the positioning of the house on the site. Given these conditions, a new approach to the site was required. The PHPP studies had highlighted the necessity for southern glazing in this small house and a more efficient relationship between the floor area and building envelope. The initial design had the house positioned at the south end (front) of the site with a north facing private courtyard to the rear. The new approach involved moving the house to the north of the site, creating a south-facing enclosed garden and upper terrace with limited fenestration to the northern aspects. This approach resulted in a house that was less ostentatious from the street, thus addressing the planning departments concerns, but also created internal spaces flooded with natural light and sunshine throughout the year. The PHPP confirmed that this design would be able to reach the Passivhaus standard (figure 3). Using PHPP, we worked through a further ten iterations of this new design to explore the full range of architectural possibilities.

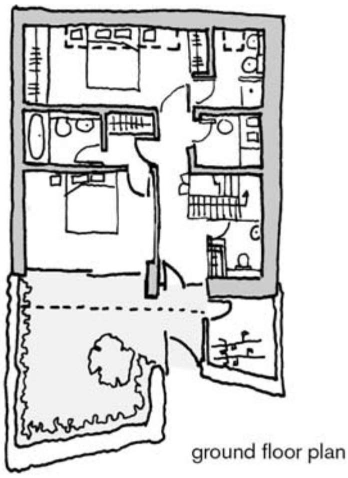

Figure 3: South garden design

This plan allows for a high percentage of glazing to be south orientated. It also provides a good ratio of envelope to treated floor area (TFA). Another benefit is the south facing outdoor area.

Result = 13kWh/(m²a)

4 Design

The final design provides bright and airy rooms with large, sliding, triple-glazed windows to the south. The house is designed to be cool in summer and warm in winter, with perfect air humidity year round and excellent ventilation, while being completely free of winter draughts. Summer temperatures are controlled by external automatically controlled blinds on the south elevation, plentiful and secure natural cross-ventilation, facilitating summer night purge ventilation, a very well insulated structure, and two green roofs. The building also incorporates a massive-wood first floor and roof construction, together with large areas of other heat absorbing surfaces. The house achieved an air pressure test result of 0.4 ach @ 50pa. Thermal bridge free detailing was used throughout the design, a static thermal modelling programme, Heat2, was used to analyse the critical junction details (figure 4).

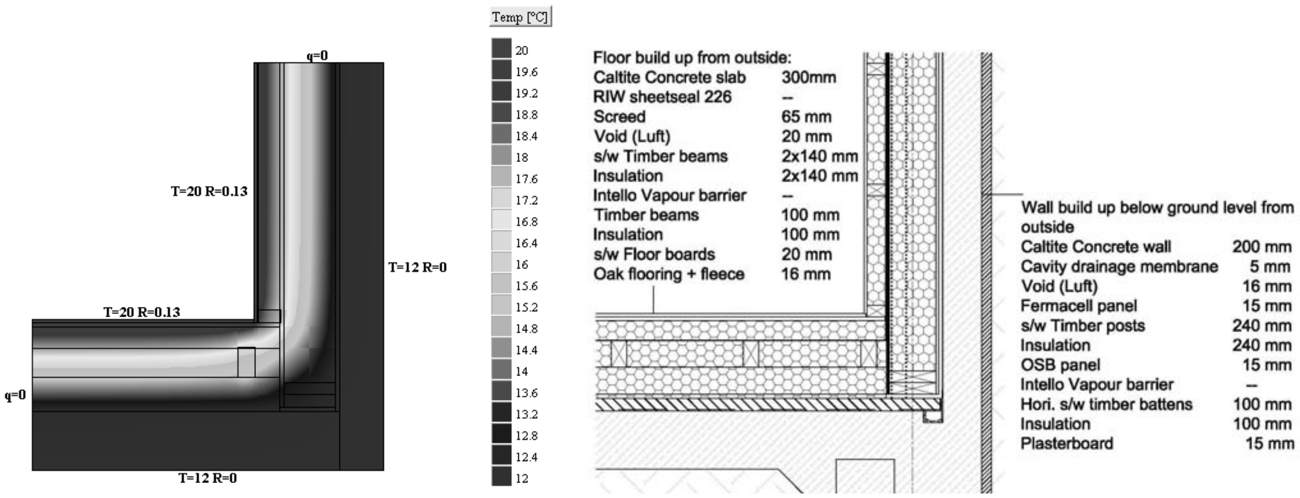

Figure 4: Heat 2, static thermal modelling and technical detail

The house uses non-toxic materials to avoid polluting the air. In addition a Passivhaus certified heat recovery ventilation system continually filters the incoming air. The resulting internal air quality is very high. A water filtration system ensures perfectly clean water for both drinking and bathing. Mains water use is reduced by an underground water-harvesting tank, which provides water for the garden. CO^2 emissions are minimised with excellent insulation, draught free construction, triple glazed windows and a solar thermal panel.

Figure 5: First floor open plan living, dining and kitchen

5 Monitoring

We have started to download the data from the temperature i-buttons at the Camden Passivhaus, these take temperature readings continuously every 10mins throughout the day and night. And although it is too early to be able see the trends necessary to accurately report on how the house is operating, so far the results look really encouraging.

Please see figure 6 below, the scale up the y-axis is temperature and the scale along the x-axis is time. The house is maintaining a very constant temperature and staying within a comfortable range. The second graph, figure 7, is from a traditional townhouse over the same period the year before, even with the heating on full in the evenings and morning the temperature did not reach 20 degrees and it was even below 10 degrees at some points (low comfort and high bills)!

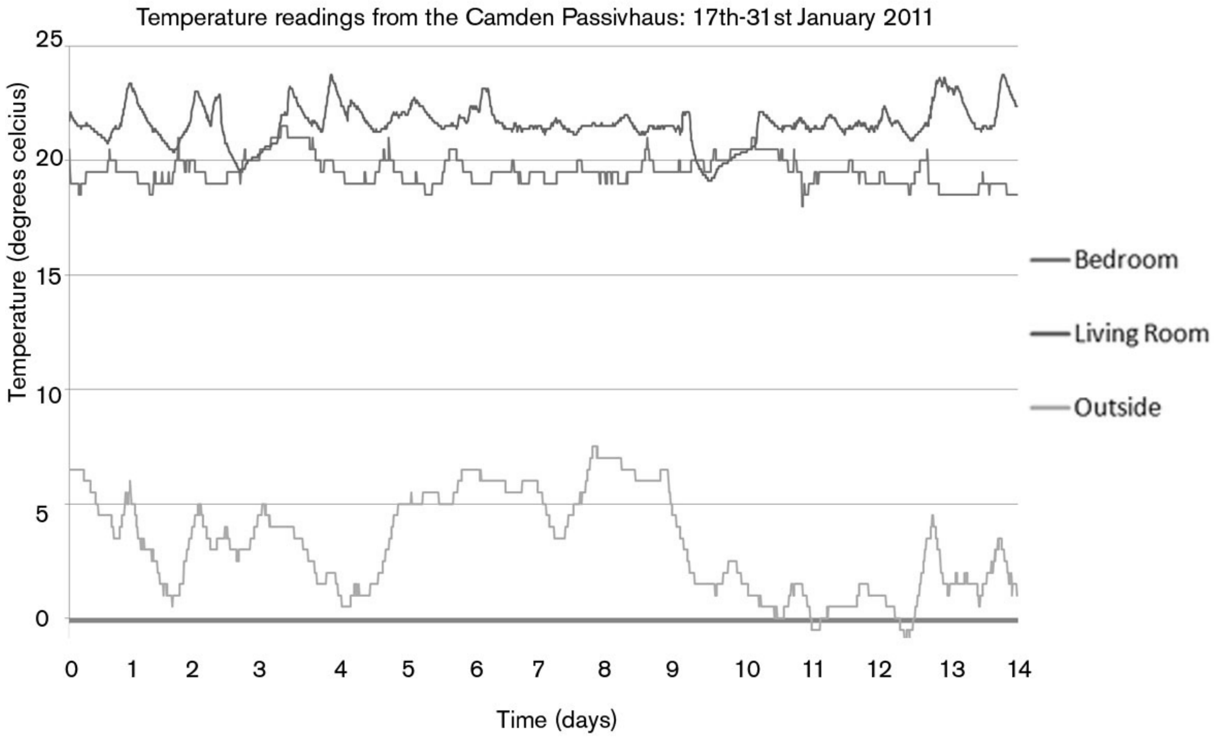

Figure 6: Camden Passivhaus temperature graph January 2011

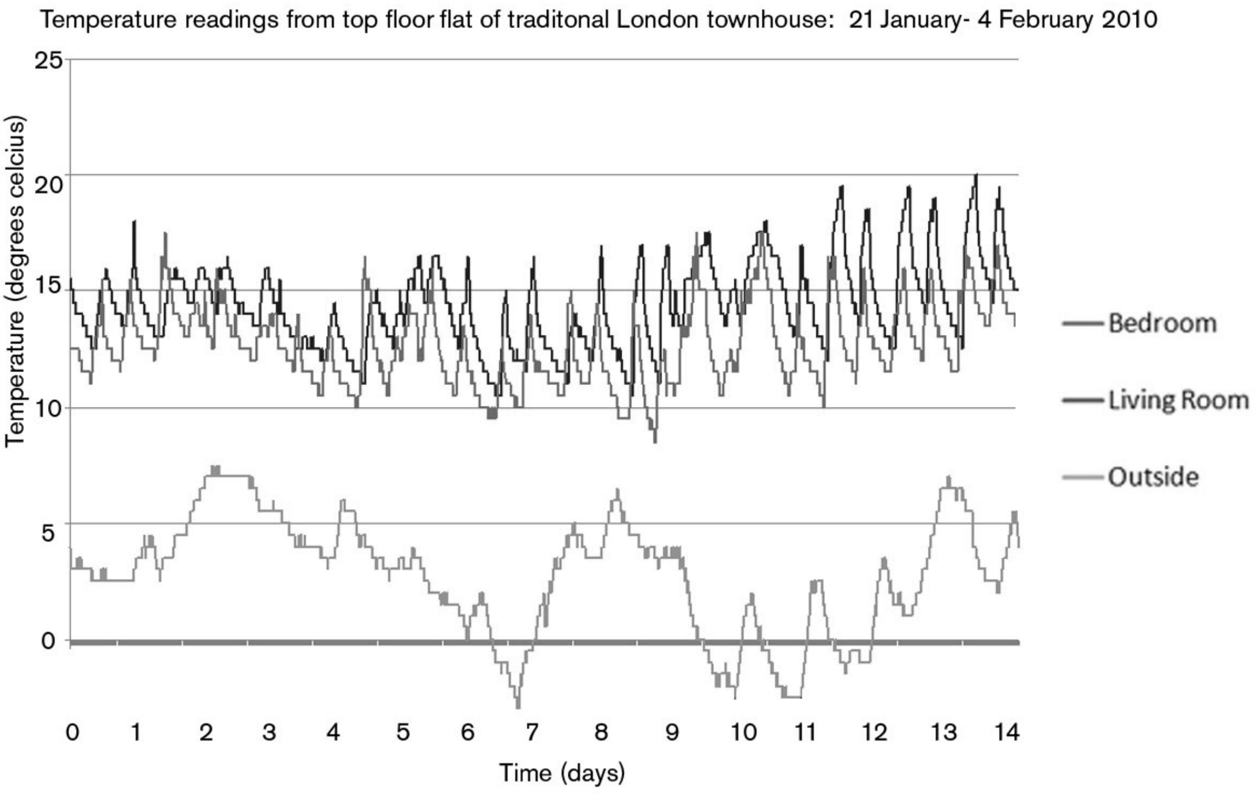

Figure 7: Traditional London Townhouse temperature graph January-February 2010

At the same time as monitoring the temperature we have taken the energy meter readings at the Camden Passivhaus, we took the meter readings on the 17th of Jan and on the 17th of Feb 2011 so we have a note of how much gas was used for this month. The gas used was 595kWh, the Passivhaus software assumes that every month 194kWh is required for the hot water, at this time of year the solar collectors will have covered about 44kWh of this. The total used for heating was therefore around 445kWh minus any inefficiency in the boiler.

Looking back to the Passivhaus (PHPP) software we used to design the house the projected amount of gas used for heating for this period was about 330 kWh at 20 degrees. The actual measured average temperature in the house from the data loggers was closer to 21 degrees; if we input this into the software it calculates that the gas usage for heating should have been 376kWh for this period of the year. So to summarise last month the house performed largely as expected, and is on track to consume less than 15 kWh/(m^2a) for its first year in occupancy.

The house has been awarded funding for monitoring as part of the UK government's Technology Strategy Board programme. As we have not yet started all of the TSB monitoring we have had to make assumptions for how much energy was required for hot water and how much the solar panel contributed so these figures may not yet be very accurate. We are also using standard average London weather data which would need to be adjusted to the actual weather over this period. The last assumption is to do with the internal gains; these are set at 2.1W/m^2 in the PHPP software but may vary from measured results.

Another reason for the slight increase will be that for the first year or so after a building has been constructed it is considered to be 'drying out', due to moisture drying out from the concrete slab and retaining walls and the internal plaster and other building materials. During this drying out period the house is expected to consume more energy than it is designed to use.

We have asked the owners if they would like to try turning the thermostat down by 1 degree to see what affect this will have on the comfort and energy use. So soon we may have some more interesting results to report!

In light of all of this, it looks like the monitoring will provide some very interesting results. We will be starting a more detailed monitoring programme in the next few weeks, and will be publishing results as we get them on bere:architects' online blog, so watch this space.

6 Conclusion

The PHPP works well as a tool not only for energy analysis but also helped to develop a design which was the most appropriate for the specific site and met our requirements and our clients aspirations for a bright, comfortable and healthy home.