Masonry Eco House

by Brian Ó'Murchú

Zero Energy Design

Located on an old 'Fordge' site outside Wicklow town, the newly constructed house of Architect Tomás Ó'Leary is possibly the first masonry built house in Ireland to incorporate the principles of zero energy design. When completed, the highly insulated, hermetically sealed house, will rely on solar energy for most, if not all of its heating requirements.

The construction of the Ó'Leary house involved the demolition of 'Ologhan's Fordge', a blacksmiths workshop located on a 150 acre farm, previously owned by seven generations of the Ologhan family, described in the auctioneers brochure as a family of 'blacksmiths and bridge builders' - the latter trade - a reference to the occupation of members of the family who emigrated to America.

The front elevation of the new house is located on the footprint of the old fordge. Long & narrow in form, the front block is purposely designed to mask the view of the other elevations from the adjacent road. As a further concession to planning requirements, the elevation incorporates a number of traditional features, including windows set within traditional style, deep reveals.

Structure

The structure of the house is economical and very easy to construct, consisting of a 215mm concrete block laid on the flat. By laying the blockwork in this way, full advantage is taken of the materials inherent structural stability. The 215mm blockwork also acts as a solid bearing for the installation of long-span window heads and beams which are necessary because of the extensive areas of uninterrupted glazing which are an integral part of the 'passive house design'. Internal beams/heads are also easily installed to accommodate open plan design.


Expanded Polystyrene Insulation

Insulation & Rendering

The concrete block structure is externally insulated with 300mm deep, high density expanded polystyrene (EPS) blocks. The insulation blocks are covered with a plastic mesh which in turn is rendered with an acrylic waterproof render. The combination of EPS, plastic mesh and acrylic render is particularly durable and impact resistant. The render is available in a wide range of colours so that no external painting is required. The insulation, mesh and render is supplied and installed by a specialist contractors 'Insuclad', located in the south of England.

The ground floor contains 300mm of EPS and the attic space contains 500mm of cellulose insulation. The roof truss is adapted to allow 240mm of insulation to be fitted around the wall plate. The U-value of the outer shell of the house is 0.10W/m^2 K, or approximately three times the level required under the current building regulations.

The level of airtightness required for passive house design is 0.6 times the house

volume per hour. To achieve this, attention to detail is required at all potential air leakage points throughout the house. To help create an airtight structure, the attic space is sealed with polythene. The polythene is carried down under a plaster coving at ceiling level and sealed against the wall prior to plastering.

The roof of the house is fitted with 12 m^2 of solar panel which is south facing for maximum performance. This area of solar panel is adequate to cater for all hot water requirements. In keeping with passive house philosophy, low energy household appliances will be used and wind powered electricity supply from 'Airtricity' is the preferred option.

Thermal Mass

To take full advantage of concrete's 'thermal mass' the concrete blocks are plastered internally. By exposing the blockwork, i.e. not insulating internally, the concrete acts as a thermal moderator, absorbing the excess heat from the large glazed areas during peak times and returning the heat to the rooms over a period of approximately 6 hours. The ability of the exposed concrete to act both as 'thermal buffer' and 'storage heater' produces energy savings by avoiding the use of cooling / air conditioning devices.

Windows

The house design features large expanses of glazing on the south elevation to absorb heat from the sun. In contrast, the north elevation has small, slit type windows to reduce heat loss. The O'Learys opted for Austrian made triple-glazed windows, which contain both argon and crypton gas. The window frames are thermally broken with a layer of aged cork between the outer oak frame and the inner pine frame. The thermal efficiency of the windows allows for a nett heat gain even on cold winter days. The potential for excessive solar heat gain through the bedroom windows on the south elevation

EPS insulation rendered with acrylic plaster

is reduced by a 750mm roof overhang which shades the windows.

Windows & doors are mounted on brackets and stand marginally proud of the outside of the ope. This detail avoids contact between the window/door ope and the frame, thereby virtually eliminating heat loss through the frame by conduction. A 150mm wide strip of sand and cement render is applied to the outside of window & door opes to create a flat surface. Sealing tape is applied to the frame and to the flat surface to create an air seal to prevent heat loss through convection.

Floors

In-situ concrete ground floors are used throughout the house. Concrete upper floors are also used and these, according to Tomás Ó'Leary are an important aspect of the house design. The upper floors are important from the point of view of sound reduction, but more importantly they combine with the concrete ground floor and wall elements to form a complete incombustible inner envelope. 'It is important to me that I design a building which gives my family the best possible chance in the event of fire - says Ó'Leary'. Concrete upper floors are a great advantage and the form of construction which I have chosen makes them very easy to install.

Mechanical Ventilation

Mechanical ventilation is an important feature of passive design. Given the high level of airtightness required for thermal efficiency, control of air change in each part of the house is essential. The mechanical ventilation system takes the waste, warm, moisture-laden air and passes it through a heat exchanger so that the cool air being drawn in is heated by the warm, stale air on its way out. A recovery rate of 80% of the heat from used air can be achieved with modern mechanical ventilation units. The mechanical system used in the Ó'Leary House cost in the order of €10,000 however, this cost is offset by the fact that no heating system is required.

The Ó'Learys estimate that building using passive house design costs approximately 10% more than alternative construction methods. However, the long term benefits of additional comfort and practically no heating bills outweigh the extra initial cost. For the Ó'Leary family however, it is clear that cost is not the entire issue. The new house is part of a new family living philosophy, and perhaps a living embodiment of the type of standards and outlook they wish to pass on to their three children. The Ó'Learys are totally enthusiastic about their family project and extended great hospitality to the many visitors who passed through the house during the construction phase.

The energy performance of the Ó'Leary house will be monitored on an ongoing basis by the Energy Research Group in UCD and by the Passive House Institute in Germany.

Ventilation ducting

Air handling unit with heat exchanger