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The Pilkington House was open to the public at the Milton Keynes Energy World exhibition last autumn.

INSULATING TO HIGHER LEVELS

D.A. Button, Dip Arch RIBA and Marketing Services Manager of Pilkington Glass, G.K. Jackson, AMCIBSE and Strategic Projects Manager of Pilkington Glass and R.R. Wilberforce, BA, MSc, MCIBSE and Market Development Manager of Pilkington Glass examine the selection and application of insulation materials in building.

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Materials used to create an insulated building should be considered as an integrated package rather than items assembled additively. There are misconceptions about achieving high levels of insulation effectively; these are relatively easy to achieve and their cost effectiveness can be shown in capital costs as well as running costs. But highly insulated housing demands a radical reappraisal of heating systems (their design and the development of new services products).

The energy exchange across windows is more complex than for other building elements; significant amounts of both conducted and radiated energy can flow through the window and from it. By choosing the appropriate glass and frame and locating them on favourable facades it is possible for the solar energy gains transmitted through a window to exceed the energy losses by conduction e.g. south facing windows with Low Emissivity coated double glazing are nett energy contributors over the winter heating season.

In recent years the concept of 'Effective U Values' has been developed in relation to the window; this provides a simple method of recognising the significant two way flow of energy. It is the conventional U value modified by the usable solar gain experienced during the heating season only and expressed in U value terms. Table 1 shows some typical effective U values for south facing elements.

Generally it is relatively easy to achieve significantly higher levels of insulation than those set out in the current Building Regulations. Consider housing:

The U value of 0.6 W/m^2K for external walls of dwellings present little problem and levels of 0.2 — 0.3 W/m^2K can be achieved relatively easily.

In roof spaces when the present requirements is for a U value of 0.35 W/m^2K higher levels of insulation can be achieved without creating problems as long as relatively simple rules are followed to prevent condensation in the resultant colder roof spaces. Ground floor insulation is easy to achieve but is not presently covered by Building Regulations. Windows too are easy to improve with double glazing and low E double glazing as alternatives to single glazing which is the basis for the present Regulations. ▶

The dwellings built at Energy World in Milton Keynes demonstrate various approaches to the provision of high levels of insulation and many houses show how traditional materials and construction methods give predicted energy costs of half what they would have been if only Building Regulations requirements had been followed.

The Pilkington house designed with Architects, Derek Walker Associates, provides a useful example of what is achievable without stretching the technology.

Energy World was an exhibition of 50 energy efficient dwellings open during August/September 1986 and set up by Milton Keynes Development Corporation *(see EIB, September)*. Developers were encouraged to build energy efficient dwellings which would serve as examplars. Designs had to satisfy current Building Regulations and, additionally an energy performance rating — the Milton Keynes Energy Cost Index. A house built only to comply with present Building Regulations would have an Index of about 180. To satisfy the Development Corporation, designs had to achieve 120 or lower. The Pilkington house, firstly, achieved 115 as a result of attention to the structure (i.e. insulation levels and orientation and type of windows) and, secondly, after the inclusion of a condensing boiler, heating controls and low energy lighting, an Index of 82 was achieved. The Index was built up as is shown in Table 2.

(The order in which the items are considered will have some influence on the apparent contribution they make to the Index reduction, but the nett result of a combination of factors will remain the same irrespective of the order of consideration).

The house is two storeys, detached, and with three bedrooms using standard brick and block construction with a 100 mm cavity fully filled with fibreglass batts. The roof is tiled over sarking with 200 mm of fibreglass quilt over plasterboard ceilings. The ground floor is solid concrete with 50 mm of rock fibre insulation below the top screed. The windows are double glazed using a low E coating and argon filling. 70% of the windows are on the south face to utilise winter solar gains.

Table 1	U Value W/m²K	Effective U Value W/m²K
Single Glazing	5.6	North 4.4
		South 2.6
		East 3.8
		West 3.8
Double Glazing	3.0	North 1.9
		South 0.7
		East 1.7
		West 1.7
Low E Bouble Glazing (Kappafloat)	1.9	North 1.10
		South 0.15
		East 0.65
		West 0.65
Solid Brick Wall	2.0	North 1.00
		South 0.70
		East 0.85
		West 0.85

Table 2	Index
1. Pilkington House built to current Building Regulations	188
2. Arrange house so that 70% of glazing faces south	175
3. Use Kappafloat double glazing	159
4. Double the mandatory level of insulation in the roof	154
5. Double the mandatory level of insulation in the walls	133
6. Introduce insulation under the ground floor	115
7. Fit the thermostatic controls and time clock to control space heating and hot water production	111
8. Fit a high efficiency condensing boiler	90
9. Replace tungsten light bulbs with low energy bulbs	82

The U values achieved are as follows:

Wall	0.26 W/m²K
Roof	0.20 W/m²K
Floor	0.43 W/m²K
Windows	1.60 W/m²K

The total glazed area is 28% of the perimeter wall area.

The current Building Regulations require a U value of 0.6 W/m²K for perimeter walls 0.35 for roofs and no insulation requirement for unexposed floors, and an area of single glazing equal to 12% of the perimeter wall. The glazed area could have exceeded 36% of the perimeter wall area, in view of the glass type used, however, summertime overheating could have been a problem had this area of window been provided. The levels of insulation have been provided using proven materials and construction techniques without having to resort to anything of a special nature.

The running costs are predicted to be about half what would have occurred if the minimum standards laid down by Building Regulations had been provided.

Does energy-efficiency increase cost?

'The cost implications of high levels of insulation and energy efficiency are often over-estimated'.

The cost implications of high levels of insulation and energy efficiency are often over-estimated. Savings in capital cost of the heating system can balance the additional costs of insulation and controls. The following case history shows how the costings can operate in practice.

Merseyside Improved Houses, a large charitable Housing Association, have built an estate of 24 highly insulated houses and bungalows using two types of heating system. The Group R&D department at Pilkington acted as energy advisors to MIH on the design, and Pilkington are monitoring the thermal and energy performance and occupants reaction.

The insulation measures included 160mm Fibreglass roof insulation, giving a roof U-value of 0.25; 100mm Dritherm cavity wall insulation, giving a U-value of 0.3; and double glazing. The additional cost of these insulation measures, compared to the minimum levels required by Building Regulations, was £600 per dwelling.

If the dwellings had been built to the minimum standards, and used a normal full central heating ▶

system with gas-fired boiler and radiators throughout, the cost of the heating system would have been £2,110 per dwelling. But, in a low-energy house, calculations show it is not necessary to have standard heat emitters in bedrooms. Conduction and convection of heat from the ground floor are sufficient to maintain comfort. (This has been confirmed in other well insulated dwellings with full central heating using thermostatically controlled radiators. Monitoring shows that the bedroom radiators rarely come on).

So alternative heating systems were costed for the MIH project. An electric system based on storage heaters plus immersion heater for hot water was costed at £1,470. A gas warm air system with stub ducts to most rooms, and multi-point water heating, was costed at £1,460. Clearly the additional cost of the insulation measures is recouped by capital savings in the heating systems.

The dwellings have now been occupied for two heating seasons and the monitoring exercise to date has revealed a high level of occupant satisfaction. The thermal environment and energy consumption obviously produce a wide spread, but on average the energy use is half of what would have been consumed if the dwellings had been built to comply with the minimum standards in the Building Regulations.

The design of low energy housing demands a radical re-appraisal of heating system design. Smaller versions of current systems may not be appropriate. Alternatives must be capable of providing better thermal response and comfort than current systems provide. Alternative systems need not result in more expensive housing particularly when the total package approach is applied to the design of the system and to the specification and type of insulation.

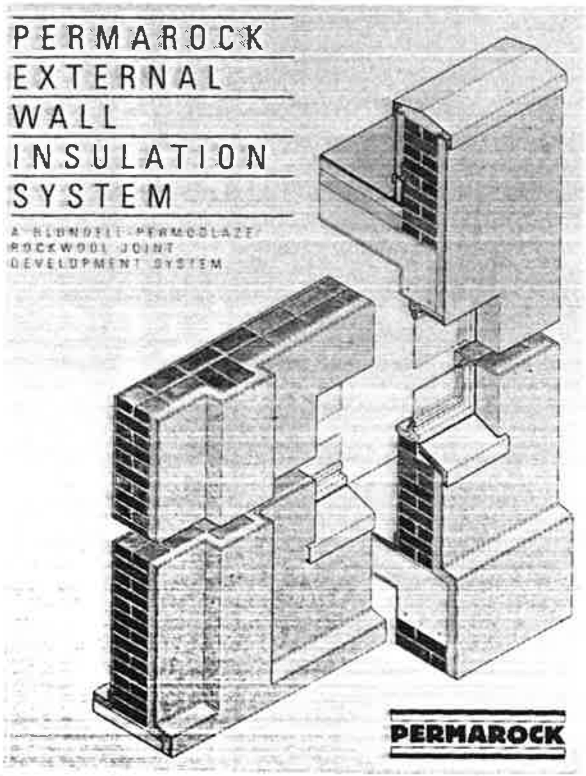
In a very highly insulated building the internal gains supply all or nearly all the heating requirements and may even exceed them at certain times; for this reason control of solar gain becomes extremely important, and they require careful evaluation and control. Very responsive low output heating systems become a necessity and the conventional gas fired water radiator central heating system becomes a feature which needs much more detailed design and specification. Long pipe runs whose heat losses could give rise to overheating in the spaces they pass through would need to be minimised, radiator sizes and positioning need rethinking and boilers which have high efficiences at part load operation need to be further developed. ●

This article is an abbreviated version of the paper to be presented at the Conference 'High Insulation: Impact on Buildings and Services Design' being organised by the Construction Industry Conference Centre Limited (CICC) in conjunction with the RIBA, RICS, CIBSE, Institute of Energy, Department of Energy and Department of the Environment on the 19th and 20th March 1987 at the University of Nottingham.

Other papers include 'Buildability of Highly Insulated and Airtight Structures', 'Commercial Evaluation of High Insulation Design', Practical Experience of High Insulation Standards in Denmark', 'Options for Building Services Provision in Highly Insulated Buildings', 'The Case for Decentralised Building Services' and Case Studies of a number of buildings, including Bournemouth Hospital and Government Demonstration Projects.

There will also be a Manufacturers' and Suppliers' Exhibition throughout the Conference.

Further details of Conference and/or Exhibition from CICC Ltd., PO Box 2, West PDO, Nottingham, NG8 2TZ. Tel: (0602) 282257.



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