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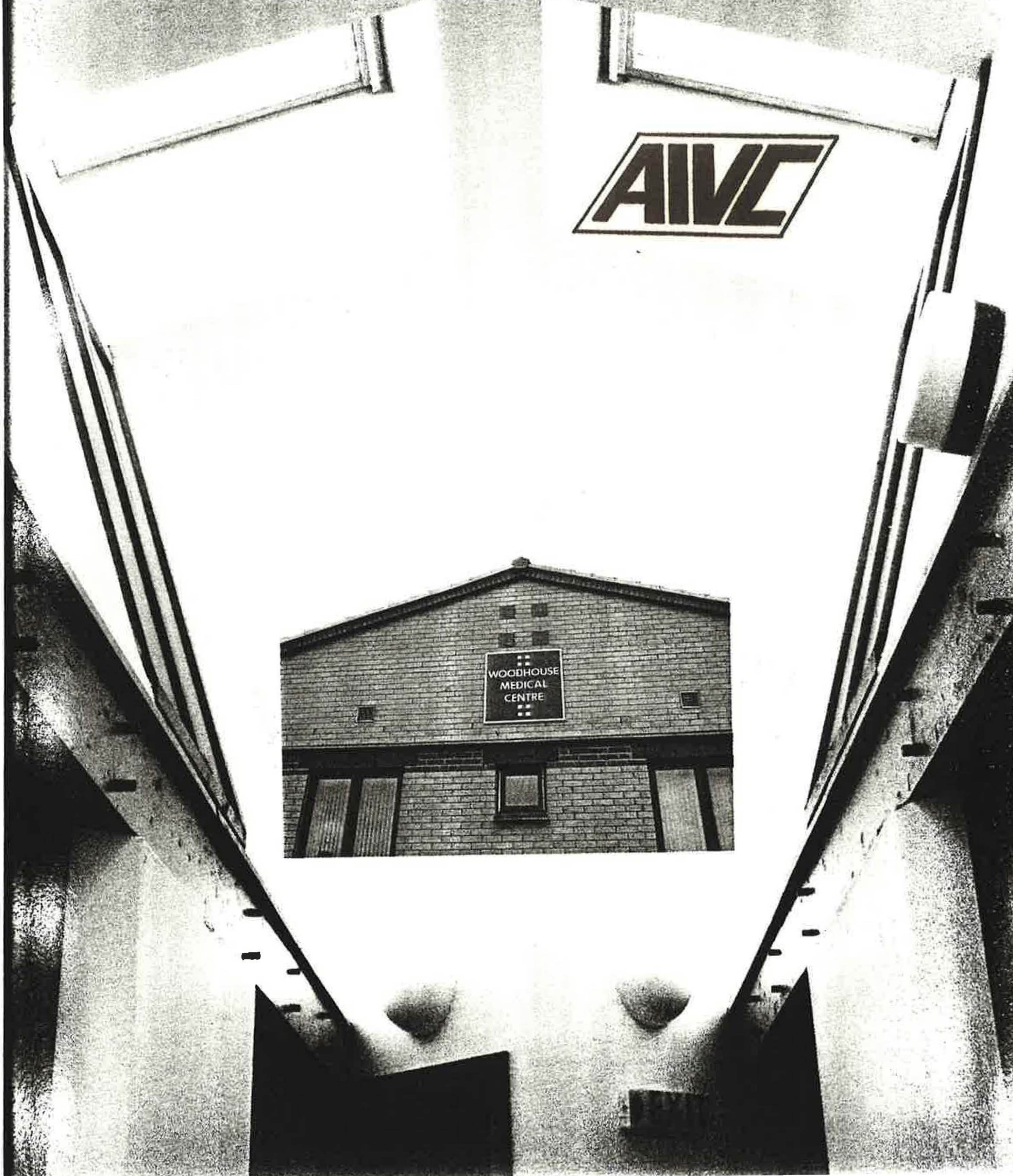
Introducing the thick building

Is energy efficient, environmentally friendly building possible on a budget? *Natasha Edwards* considers the principles and the practice at a Sheffield surgery.



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A new medical centre in Sheffield, Woodhouse Medical Centre, has been designed to give an estimated 80% saving on space heating and light costs. One of the largest super-insulated structures in Britain, high energy efficiency is achieved through insulation rather than services – this is not a "smart" building but a "thick" building.

The architectural partnership of Brenda and Robert Vale has long experience of energy saving designs and a firm belief in the environmental responsibility of the architect. For example, the architect must consider from the outset all aspects of the building and its environment including structural and services needs. With 50% of CO_2 emissions attributed to buildings, they believe that architects must be aware of how energy efficient buildings can contribute to a reduction of global warming. For this reason the Vales have attempted to eliminate the use of cfcs in insulation and taken on the additional concept of ecologically sound materials.

The basic stepped, terrace structure and internal layout were determined by the long, narrow sloping site and the need for a single-storey building giving full disabled access. Although not an intrinsically energy efficient shape, this format does allow a large amount of natural daylight.

There is nothing radical about the external appearance in buff brick with polychrome red and blue facings and a pitched grey tile roof, although due to the thickness of the roof, the eaves have become a significant visual element. The use of brick, tile and wood and use of traditional masonry construction was also fuelled by the classic principle of honesty of materials – there is no hidden steel frame here. An Arts & Crafts influence is displayed in the external buttresses and exposed wooden lintels.

Behind this simple structure lies a strong philosophy of putting ideals into practice. The Vales wanted to demonstrate the viability of producing a non-hazardous, radically different building within the constraints of a real budget. Unlike experimental energy-saving housing as at Milton Keynes, Woodhouse Medical Centre was not funded by grants but had to comply with the strict financial limits and spatial regulations laid down in the Family Practitioner Committee's "Red Book".

The client was a doctor who had seen the Vales' previous energy saving design for a surgery (see *Building Services*, April 1988). The local Family Practitioner Committee is keen for all practices to be housed in purpose-built surgeries and thus encouraged the practices (two groups of doctors in blocks A and B and a dentist in block C) to move out of their existing, somewhat unsuitable, accommodation. While they are completely autonomous, the three linked buildings were able to share on building costs.

Green materials

Working from the precepts of using natural, energy saving, environmentally non-harmful materials and the desire to maintain the ecological cycle, the architects aimed to produce a building that is, as far as possible, "green".

Deciding what are "green" materials is still a subject that needs much research – as yet little work has been done on, for example, the fluorine produced in brick manufacture. It is frequently hard to obtain data on material content and manufacturing processes.

Obviously there are many factors to be considered and counter-balanced – energy consumption, scarce resources, manufacturing waste by-products and pollution – what may win on one count may be way down on another. The energy consumption factor was one of the foremost considerations applied at Woodhouse, a logical continuation of the general low energy concept. Such information as is available on the energy content of materials suggests that brick, concrete and mineral fibre insulation as used here have a relatively low energy content compared to so-called "high energy" materials such as aluminium or steel, which were used as little as possible. In addition, a UK source was used where possible to reduce transport energy.

The centre uses a large amount of wood for load-bearing timbers, lintels, window frames and roof structure. Softwood was chosen in preference to hardwoods, out of a desire to avoid destruction of tropical rainforests.

The maximum amount of natural wood has also been used for internal furniture, shelving, cupboards etc, this is seen as a way both of "locking up carbon" and to maintain the forest cycle. In addition, wood is a simple, low energy material.

The use of polystyrene and polyurethane-based insulation sprays which use cfcs as blowing agents has been abandoned in favour of natural, mineral-based rockwool and fibreglass.

A high mass envelope

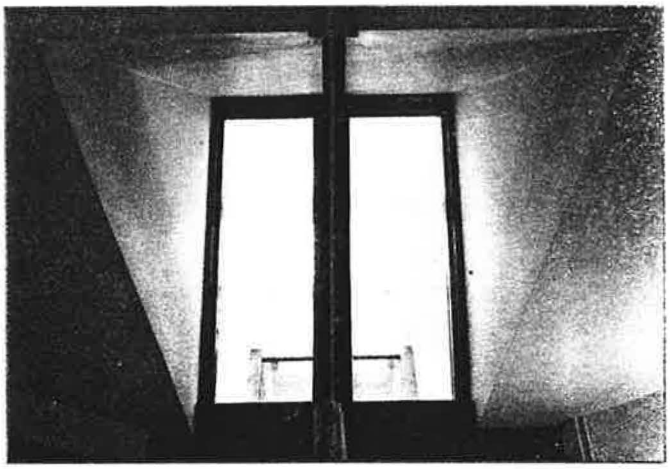
By modifying conventional masonry construction techniques to accommodate the increased mass, an appropriate structure has been developed to create a building with insulation levels that far exceed even the revised *Building Regulations* to meet Scandinavian Standards. With enormously thick insulation in the roof plane, together with heavily insulated walls and underfloor, the result is the creation of a very warm envelope and extremely low U-values compared to a conventional building.

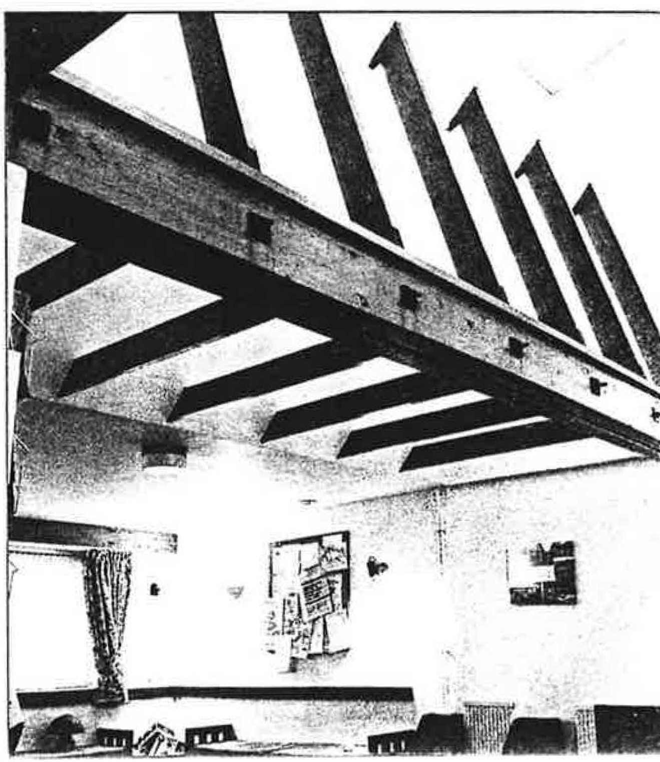
U-values in W/m^2K:

roof 0.09	walls 0.2
glazing 1.6	floor 0.15

The design was based on the principle of a high mass structure and simple heat recovery system. Solar gain could not be a significant factor due to the orientation of the site and because, unlike in domestic housing, privacy is important and as the building will be left unsupervised outside surgery hours, it is not suitable for large areas of glazing. Instead the required heat is gained largely from the patients.

Window frames are high performance softwood with glazing in low emissivity glass, each unit consisting of two sheets of 4 mm





Above right: Light wells let natural light from the corridor into consulting rooms. ***Below:*** The waiting room in block B is open and inviting with exposed wooden trusses; light fittings use low energy fluorescent lamps.

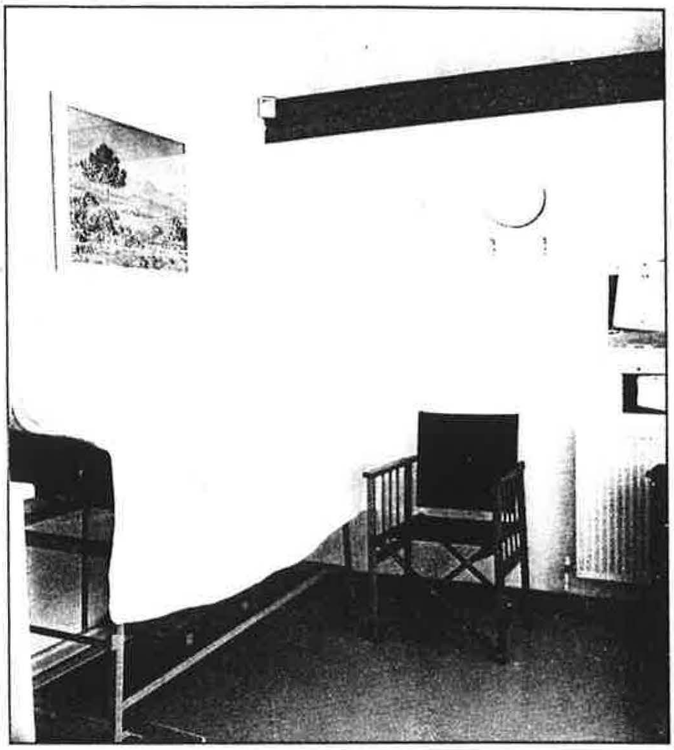
glass with a 12 mm argon filled cavity. The low emissivity coating reduces transmission of long wavelength heat radiation produced within buildings by lights, radiators, absorbed and re-radiated solar energy and body heat, reflecting it back into the building. Roof lights are triple glazed and side windows are double glazed.

Roof structure

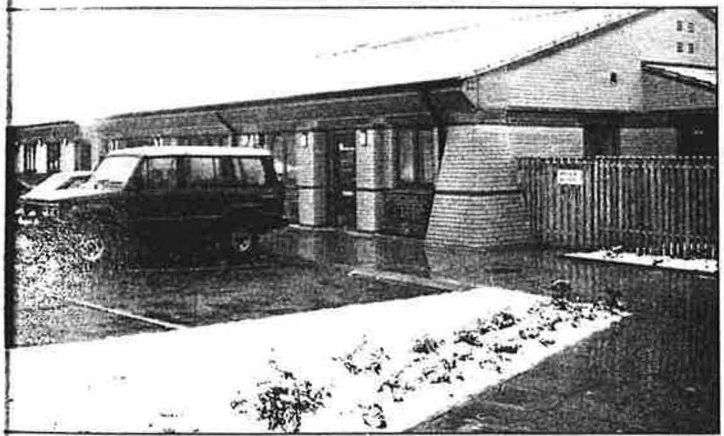
Experience from their previous low energy surgery led the architects to develop a novel technique of roof construction, whereby the structure is in essence a double roof. The thick insulated structure was constructed above a deck of chipboard laid on the roof trusses. By this method, the vapour barrier, an extremely tough Swedish-made reinforced polyethylene sheeting held on by tape, is put on first and a "second roof" constructed above. This was found to be simpler than more orthodox methods which involve adding the vapour barrier last, from below, to the underside of the roof sandwich. The outer rafters are attached to horizontal struts with German spacing screws to hold the required distance.

Roof sandwich (from exterior in):
- ☐ roof tiles on battens;
- ☐ underslating felt;
- ☐ timber rafters;
- ☐ air space to allow air flow;
- ☐ 350 mm rockwool mineral fibre insulation;
- ☐ polyethylene vapour barrier, all joints sealed;
- ☐ 19 mm moisture resistant chipboard.

Wall structure (from outside):
- ☐ frost-resistant facing bricks;
- ☐ 150mm water-resistant fibreglass "dritherm" insulation;
- ☐ inner shield of thermalite shield block.



Above: A consulting room, note the smallness of the radiator.



Above and below: Buttresses with creasing tile detail show an Arts & Crafts influence, wooden eaves reveal the thickness of the roof sandwich.

Floor structure:
- ☐ 150mm concrete slab;
- ☐ damp proof membrane;
- ☐ 150mm jablite.

With this degree of insulation a long drying-out period was necessary to minimise potential problems of damp and condensation. So far there has been some initial damp through the floor, but no trouble with walls or ceiling. Materials have to be carefully installed to avoid condensation or freezing within cavities. Non-ferrous materials for materials, such as pipework, outside the insulating shield were used to prevent rusting. At the corbels the insulation was folded round angles to avoid exposed end grain which could allow water penetration. In practice the very thickness of the insulation means that moisture is unlikely to percolate far. Frost-resistant exterior bricks were used against the risk of frost damage to cold external walls, while the use of wooden lintels is less likely than steel to lead to cold bridging.

Interior design

Internally, the exposed stained wood, load-bearing lintels run either side of the central corridor, which is the full-height of the building and lets light into the centre through roof lights. Rooms open to either side off the corridor. Angled doors facing the patient's approach make this space welcoming rather than forbidding and break the uniformity of a traditional corridor.

Internal walls are solid brick as an important aspect of the design was the need for sound-proof consulting rooms. Standard wooden fire doors were used internally for the same reason.

Each block is completely self-contained with its own reception and waiting areas, plus a large number of consulting rooms, office space, treatment room and rooms for the nurse and health visitor. Within a very simple structure each medical practice has been able to stamp its own character on the interior and choose their own internal layout. Stained wood shelving, cupboards and waiting room benches designed by Brenda Vale and the animal fibre and wool carpets continue the principle of natural materials.

Heating and ventilation

With the high level of insulation, internal temperature should be extremely stable. Each block is heated by a small wall-hung gas-fired condensing boiler housed in a store cupboard and operating on a seven day timeswitch. These are standard small domestic units each serving 17 small radiators, sufficiently over-sized, together with the long pipe run, to allow the boiler to operate frequently in a condensing mode. Room temperature is controlled by thermostatic radiator valves.

There are three levels of mechanical ventilation: heat recovery, trickle ventilators in windows, and openable windows. Heat recovery is by a centralised system for each block through a Bahco heat recovery unit in the roof space of each block and ducting to the various rooms.

Hot water

A hot and cold water supply was necessary for almost every room. Hot water is provided by small individual under-sink electric water heaters at each outlet. The choice of electric water heating was seen by the architects as something of a compromise on ideals. However, the length of each block, plus the number of outlets required, precluded the use of a centralised system as heat loss from the long pipework would have been too great. Additionally as water is needed frequently but only in small amounts, such a system would have been very wasteful in run off.

Lighting

Although windows must not be too large in order to maintain privacy and retain heat, the combination of windows and roof lights provide the centre with ample natural light.

Triple-glazed velux roof lights let natural daylight into both the central corridor and through angled lightwells into each consulting room. This gives each room two directional natural light and reduces the necessary amount of artificial light.

Artificial lighting is all low energy fluorescent, with 11W fluorescent Beta uplighters in the corridor and waiting room, low energy spots and Philips PL lamps.

The medical centre has now been in use since March 1989 and certainly provides a light and friendly environment for both staff and patients. Unfortunately there are not sufficient resources to allow detailed monitoring, although initial reports indicate that the building is functioning well.

Super-insulation is frequently discounted because of high capital costs resulting in long payback periods. In fact despite rising costs, the centre actually came out under budget. Obviously, the cost of insulation materials was slightly more expensive than is usual, so economies were made elsewhere in the specification for the bricks and roofing tiles and in the use of standard window units where appropriate.

Above all, this is a real building designed to meet everyday working needs which could provide a prototype for similar buildings. The achievement of a green building as far as possible is in the words of the architects "a case of making intelligent compromises" – a balancing of environmental and financial considerations. It is this that makes Woodhouse particularly valuable over grant-funded schemes or housing for individual clients where the designer can risk more controversial aesthetics. Perhaps more than anything it is a matter of awareness of issues and a holistic approach to the built environment. The architects are already working on a further medical practice and a low-cost energy saving housing scheme.

Woodhouse Medical Centre, Sheffield

Architect & services
Brenda & Robert Vale
Structural engineer
E J Allott & Associates
Quantity surveyor
Gordon Hall, Grayson & Co
Contractor
Wildgoose Construction
Plumbing and heating subcontractor
C Woodhouse (Plumbers)
Electrical subcontractor
J T Owens

Principle suppliers
Insulation: Rockwool; Fibreglass
Vapour barrier: Monarflex

Total floor area: 635 m^2
(Block A: 270 m^2 approx, Block B: 270 m^2 approx, Block C: 100 m^2 approx)
Total cost: £350 000

Specific heat loss: 0·28 W/m^3K = 0.81 W/m^2
Total loss: 512 W/K
(To *Building Regs*: 2089 W/K)
(To new *Building Regs*: 1960 W/K)

Boilers: Trisave Turbo 30
Heat recovery units: Bahco
Thermostatic radiator valves: Danfoss
Rooflights: Velux
Windows: Boulton & Paul
Luminaires: Beta; Philips