BRE Info
...Latest research in
IP 20/89
November 1989
CI/SfB (56.34) (R3)

An energy-efficient refurbishment of electrically heated high-rise flats

D D Ward, BSc

This paper describes the results and lessons learned from the extensive monitoring of two blocks of high-rise flats which had a comprehensive package of energy efficiency measures included as part of a major refurbishment programme. It is addressed to architects, engineers, housing officers and tenants in housing authorities, housing associations and other bodies concerned with the maintenance and refurbishment of high-rise blocks.

INTRODUCTION

There are over 4500 blocks of flats of six storeys or more in the United Kingdom, providing more than 300 000 individual dwelling units. Most of these blocks have poor standards of thermal insulation compared with those specified in current Building Regulations, and as a result the flats are difficult to heat. Many have electric underfloor heating, which is perceived as inefficient and expensive to run by the occupants. As a result, even more expensive on-peak electric fires are often used instead.

To compound the problem of these blocks, they are often occupied by tenants on low incomes. The combined effect is that occupants cannot afford to heat their flats adequately, and the flats can suffer acute problems of condensation and mould growth. This in turn leads to a major maintenance and redecoration bill for the landlord. It is thus in the interests of the landlord to ensure that these properties can be heated adequately at a cost which is affordable to the tenant. This increases the ease of letting and general popularity of the flats, resulting in fewer unoccupied flats and hence increased rental income, and reduces the maintenance costs and tenants' complaints.

THE ENERGY EFFICIENCY PACKAGE AT SANDWELL

The Blades Rise Estate in Sandwell comprises six 12-storey blocks of 95 one- and two-bedroomed flats built in the 1960s (Figure 1). The construction is of 'no-fines' concrete, either faced with brickwork or rendered. The original wall U-value was 1.3 W/m²°C, and heating was by underfloor electric cables in the living-room and hall only.

Figure 1 One of the blocks of flats on the Blades Rise Estate in Sandwell

bre Building Research Establishment
DEPARTMENT OF THE ENVIRONMENT
Building Research Establishment
Garston, Watford, WD2 7JR
Telephone 0923 894040
Telex 923220 Fax 0923 664010

In 1987, following a pilot study by Midlands Electricity Board, the local authority decided to refurbish the flats, incorporating a package of energy efficiency measures. The authority's aims were to eliminate condensation and increase occupier comfort by providing affordable heating.

This project was monitored under the Energy Efficiency Office's Energy Efficiency Demonstration Scheme and managed by the Building Research Energy Conservation Support Unit (BRECSU) at the Building Research Establishment. The aims of the monitoring were to assess the ease of installation of the package, its benefits in terms of energy savings, reduced fuel bills and increased comfort levels, and the reaction of the occupants.

The following package of energy efficiency measures was installed in three blocks of one- and two-bedroomed flats:

- Insulated dry lining applied internally to the external walls and stairwells, giving a new calculated U-value of under 0.5 $W/m^2°C$
- A new electric heating system consisting of Economy 7 storage heaters supplemented by a panel convector and wall-mounted downflow heaters
- Draughtproofing with a silicone tube to all windows and brush strips to the bottom of the entrance door
- Insulation of the exposed ground floor, by applying insulated panels to the ceiling areas of the bin store and storage areas, and extra insulation to the roof
- A more flexible water heating system using an Economy 7 controller

The dry lining consisted of 25 mm polyurethane foam with a 9.5 mm plasterboard facing and an integral vapour barrier. In addition, a dry lining with a 12.5 mm thickness of foam was used around window reveals. The dry lining was fixed using plaster dabs and insulation fasteners.

Economy 7 slimline storage heaters were situated in the living-room, hall and one bedroom. They were supplemented by a panel convector in the second bedroom, where applicable, and by wall-mounted downflow heaters in the kitchen and bathroom. The installation made use of the existing underfloor heating circuits where possible. New cabling was installed using mini-trunking, which proved a quick, unobtrusive method.

The measures were installed at the same time as new kitchen units were fitted and when some redecoration was due. The total cost of the refurbishment, including the kitchen units, was about £2000 per flat. The cost of the energy measures alone was between £1100 and £1400, depending on the size and position of the flat within the block.

PERFORMANCE EVALUATION

Following completion of the refurbishment, 30 flats in two blocks were monitored for a year, from October 1987 to September 1988. On-peak and off-peak electricity consumptions were metered for space heating and water heating separately, in addition to the total consumption. Temperatures were recorded in the living-room and the main bedroom, and a spot reading of relative humidity was taken every fortnight in the living-room. Similar monitoring was carried out for the same period in 29 flats in an unimproved 'control' block on the nearby Lions Farm Estate.

In order to assess the tenants' comfort levels and reaction to the refurbishment, a social survey of all 59 flats was carried out in February 1988. Tenants were asked about their heating patterns, their comfort levels, the incidence of draughts and condensation, and whether the improvements in the trial blocks had been worthwhile.

Of the 23 flats in the trial group which provided a full year's monitored data, 17 were two-bedroomed flats and 6 were one-bedroomed flats. All the control flats were two-bedroomed flats, of which 19 provided full data. To ensure a valid comparison, only the two-bedroomed flats are compared.

Between mid-October and mid-April, taken as a representative heating season, monitored living-room temperatures in the trial group averaged 20°C, 5°C more than in the control group. Bedrooms in the trial group averaged 16.4°C, over 3°C more. Overall, assuming the bedroom temperature to be representative of the rest of the house, the mean temperature across the whole flat in the trial group was 17.4°C, compared with 13.9°C in the control group, a considerable temperature benefit.

The spot readings of relative humidity in the living-room averaged 53% in the trial group, compared with 63% in the control group. This improvement was due entirely to the increased air temperatures; the moisture content of the air was slightly higher. Tenants in the control flats reported major condensation problems, often resulting in mould growth, whereas in the trial flats these problems had been eliminated.

The average space heating consumption in the trial group was 4920 kWh (17.4 GJ) over the year, at a cost of £113 to the tenant. Hot water consumption was a further 1800 kWh (6.2 GJ), at a cost of £52. Space heating and hot water therefore cost a typical tenant just under £4 per week, including standing charge, when averaged over the year (Figure 2).

In the control group, annual space heating consumption was estimated at 3290 kWh (11.8 GJ), costing £182. The hot water consumption was 2170 kWh (7.8 GJ), at a cost of £62. Thus, whilst space heating consumption in the trial group rose by 50%, the realised saving in tenants' space heating and hot water costs was £79 a year, or 27%, taking into account a slightly higher standing charge for the Economy 7 tariff. The cost saving was attributable to

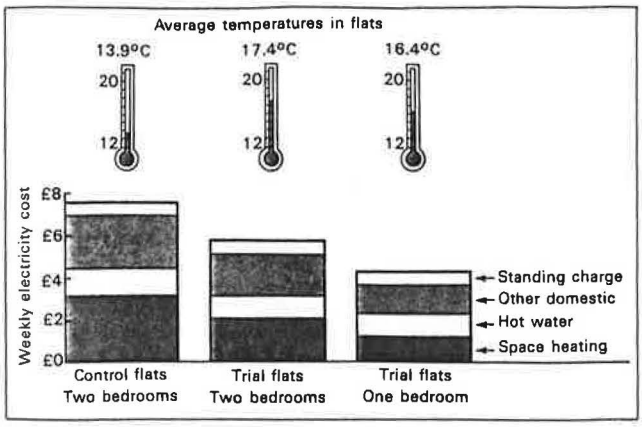

Figure 2 Temperatures during the heating season, and cost of electricity averaged over a year

the high proportion of electricity which was charged at the off-peak rate. A saving in other domestic use was also apparent; this may be due to the more flexible Economy 7 system. Alternatively, it may be a consequence of social differences between the two groups, so this benefit is not included in the assessment of cost-effectiveness below.

Tenants responded to the improved heating system by choosing to spend much the same amount on fuel as before the refurbishment, thereby attaining significantly improved temperatures.

It is clear that the effect of the energy efficiency measures was to enable the tenants to increase the temperatures in their flats and still realise a significant cost saving. The result was the elimination of condensation problems, a major goal for the local authority, and the provision of warm, comfortable dwellings which were easier to let.

COST-EFFECTIVENESS

Using the Building Research Establishment Domestic Energy Model, BREDEM[1], it is possible to quantify the benefit to a tenant of increased temperatures by estimating how much it would have cost to heat an unimproved flat to the same temperatures. This approach values the average increase in temperature achieved in these flats at £260, giving the overall benefit of increased temperatures and fuel bill savings to be £339.

At an average capital cost of £1312, the energy measures have a simple payback period of 4 years. Assuming a discount rate of 5% and a lifetime of 20 years, the net present value of the investment is £2790. An alternative approach is to consider the internal rate of return on the capital investment, which is 25% over a 20-year lifetime. All these investment appraisal techniques indicate that the package is highly cost-effective.

Some of the major benefits to the local authority are harder to quantify. These include reduced maintenance costs, a reduced number and duration of voids, increased 'letability' and much happier tenants.

Overall, the trial flats were well liked by their tenants, who thought the refurbishment package had been well worthwhile, both in terms of improving comfort and reducing their fuel bills. The package clearly achieved the aims of the local authority to improve environmental conditions in the flats and increase their attractiveness to tenants.

The measures were installed without the occupants moving out. As a result, the tenants generally found the installation disruptive. Good liaison with the tenants, to explain the work being carried out and the benefits that would result, reduced the impact of this disruption. If sub-contractors are reasonable in informing the tenants of their requirements, this disruption can be further reduced. The package offered no other installation problems.

RECOMMENDATIONS

The local authority is very happy with the refurbishment package. The package is recommended for replication in other blocks of flats with similar problems, with the following refinements:

- The insulated dry lining should be extended from the external walls along the ceiling and party walls for a distance of approximately 50 cm, to counter the cold-bridging effect of the floor slabs and further reduce the condensation risk.

- Consideration should be given to the provision of ventilation, possibly through occupier-adjustable trickle ventilators and mechanical extract fans.

- Storage heaters should be installed in the living-room and main bedroom, as these are the two main occupied rooms, even if other rooms appear to have higher heat losses. A hall heater may be superfluous; certainly in this project it was hardly used.

Fewer than 10% of all high-rise blocks of flats have been insulated. The package of energy efficiency measures demonstrated in Sandwell could be installed in many high-rise blocks. If 25% of all existing blocks were similarly refurbished, the national savings in energy costs alone would be worth approximately £20 million per year. At an annual penetration of 5%, this potential could be achieved by the year 2000.

REFERENCE

1 **Anderson B R, Clark A J, Baldwin R and Milbank N O.** *BREDEM — BRE Domestic Energy Model: background, philosophy and description.* Building Research Establishment Report. Garston, BRE, 1985.

This work has been undertaken as part of the research, development and demonstration programme of the

Energy Efficiency Office

DEPARTMENT OF ENERGY