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AIUC 1987

WALL INSULATION

There is more than one way to insulate a wall and, in the following article, Simon Napper examines the main methods and looks at their respective advantages.

Buildings consume approximately 50 per cent of the United Kingdom's primary energy, with housing accounting for almost 30 per cent of the total, according to the government-funded Building Research Energy Conservation Support Unit (BRECSU). It has been estimated that at least a quarter of this consumption could be saved by the year 2000, without any reduction in standards, simply by the widespread application of currently available technologies.

There are many areas where improvements can be made, from building management services to such basic technologies as efficient weatherstripping round doors and windows. And not least of these, particularly when major refurbishment or new building work is being carried out, is the uprating of the insulation performance of external walls.

At present the Building Regulations require opaque walls in new buildings to have a U-value of 0.6 W/m²°C. Various proposals are however under discussion which if adopted would tighten up the limit. The BEEC wants this to be reduced to 0.35. Another suggestion, put forward in a recent government Buildings Update document, puts forward a recommended level of 0.45 but there would be a degree of flexibility with the possibility of 'trade-offs' for better thermal efficiency elsewhere in the building envelope.

Whatever happens, the message is clear: Not only is energy efficiency desirable for its own sake, it is increasingly required by regulatory bodies.

With 75 per cent of existing buildings expected to remain in use into the next century, it is evident that considerable uprating will have to be done to enhance energy efficiency. Although the walls of all new domestic and commercial premises must achieve a thermal performance of 0.6, old solid wall buildings, of which there are about eight to ten million in the UK, achieve an average of only 2.2. Those of uninsulated cavity wall construction, which came into general use in about 1922, do slightly better at an average 1.45 W/m²°C.

Uprating these structures to the current level for new buildings should cut down heat loss by 70 per cent and 60 per cent respectively, with commensurate savings in energy.

'A range of materials is available.'

Materials

A range of materials is available for ensuring a required level of insulation in the external walls, and these are adapted to the different applications for which they are used. For example, internal dry lining would be an obvious candidate if the internal structure and decor of the building was being substantially altered. External wall insulation systems are particularly useful where the weather resistance of the structure has become suspect.

New Buildings

Most modern buildings employ a cavity between the outer and inner leaf: indeed since 1947, this form of construction has been mandatory. Average cavity width is 65mm.

Many buildings make use of dense insulating blocks in the inner leaf of the external walls. In addition, insulation materials are placed in the cavity either to fill or partially fill the gap. These materials are either installed as the walls are under construction, for example in the case of insulating boards and mineral fibre insulation batts, or in a retrofit operation.

The retrofit materials, like urea formaldehyde (uf) foam or the dry fill systems, as well as the external wall insulation systems, are normally installed by specialist sub-contractors working to BSI or Agrément specifications. Although mainly used in refurbishment work, they can also be used in new-build projects, offering certain advantages to the contractor. They will be discussed at greater length when dealing with renovation.

For total cavity fill, insulation batts made from layers of glass or mineral fibre and treated with water repellent are used. Water will not pass through the batts but may drain down through the laminations.

Insulation boards are made from a variety of materials, including expanded polystyrene, extruded expanded polystyrene, polyurethane foam, glass fibre and polyisocyanurate foam. The boards are normally fixed against the cavity face of the inner leaf. ►

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Special precautions

For partially filled cavities, especially those with a maintained cavity of more than 50mm, faults that might lead to rain penetration are similar to those for unfilled cavities, The main additional risk being that of a displaced board bridging the cavity and conducting moisture to the inner leaf. With maintained cavities of less than 50mm, the state of wall ties, builders' debris and excess mortar become more important in this regard.

For totally filled cavities, the insulation must be kept dry during installation and the design of the structure needs to ensure that water entering the cavity is directed away from the inner leaf. Batt thickness and height are also important: batts that are too thin are likely to slump and promote a passage for the moisture from outer to inner leaf; and if the height is wrong they will not line up properly with the wall ties, causing gaps.

Although cavity insulation reduces the risk of condensation, because the inner leaf is kept at a higher temperature, it also increases the possibility of cold bridges and subsequent local condensation and staining Areas requiring special attention are: the ground floor to external wall junction, the roof to wall junction, reveals and lintels.

New developments

It is possible to uprate the thermal performance of external walls well beyond the 0.6 U-value at present required, and work has been carried out on the economics of insulating to 0.3.

Among the various ways of constructing to such higher levels are, for example, widening the cavity to take a greater quantity of insulant, either total or partial fill. This approach can be quite expensive in capital outlay and extra wall ties, wider foundations and extra detailing round openings will be required.

For solid masonry construction, a thicker layer of insulation can be incorporated under a protective external render. In Timber frame construction, filling the space between the timber studding with non-structural insulant is not expensive.

Retrofit

One other approach to new building, briefly mentioned above, is that of insulating the walls when the building is complete by employing a specialist sub-contractor. Especially if using one of the cavity insulation or external wall insulation systems, the work is carried out to BSI or Agrément standards.

Being part of the 'finishing' of the structure it is kept out of the main building process. The bricklayer does not need to learn any new techniques either. The sub-contractor is responsible for carrying out the work to the required standard and since the materials are not delivered to site in advance there are no problems with storage, pilferage, etc. Retrofit cavity fills also obviate the problems of keeping the insulation materials dry during the course of the construction work.

Refurbishment

Retrofit for new building is as yet a small, but growing sector of the specialist insulation contracting market. By far the larger area is the refurbishment of existing buildings within both domestic and commercial areas.

There are three main approaches to the upgrading of outer wall insulation in existing buildings: cavity wall insulation, dry lining and external wall insulation. A fourth method is the application of spray on insulants to the inside of the building although this method is generally used in industrial situations.

Cavity wall insulation

Cavity wall insulation involves the mechanical injection of a suitable insulant into the cavity between outer and inner leaves. Air is trapped by these systems and acts as a barrier to heat loss. In an unfilled cavity, free-flowing currents of air transmit heat from the warmer inner leaf to the colder outer (or the other way around in cases of high solar gain during summer). This can also lead to draughts within the building.

Most Buildings of double-skin masonry construction are suitable for insulation in this way, although complete wall surfaces, and preferably the whole building, should be insulated at the same time. Where the wall is over 12 metres in height a relaxation of the C9.3 Building Regulation is required, although many such structures have been successfully insulated over a number of years.

Systems

There are three widely used systems for injected fill cavity wall insulation: urea formaldehyde (uf) foam; blown mineral fibre (glass or rock); and expanded polystyrene beads and granules.

UF foam

Raw materials for uf foam are manufactured to BS5617 and installed in accordance with BS5618. The foam is produced on site using the uf resin and a foaming hardener. The mix is injected in through holes drilled in a grid pattern on the wall to ensure a thorough filling. The foam sets immediately after injection and dries by evaporation of the water content through the porous outer leaf. Once dry it is resistant to water penetration, is chemically inert to normal building materials and resists attack by rot, fungi and vermin. Formaldehyde gas is given off during the curing, but not at dangerous levels — although very occasionally some discomfort may be experienced for a short period after the installation. It is a very economical and effective method of insulation within the limits contained in BS5618. It cannot be used in timber frame constructions.

Uf foam has a nominal k-value of 0.040 W/m°C and a typical installed density of 10kg/m^3.

Mineral fibre

The mineral fibres used for cavity wall insulation consist of mechanically granulated spun glass of rock fibre, treated with a binder and water repellent. Production of the material and installation procedures are covered by the British Board of Agrément (BBA) certificates for each system.

Once installed it should last as long as the building. The fibres are resistant to water penetration and due to their random orientation after injection will not transmit water across the cavity.

Mineral fibre blown mineral fibre has a nominal k-value of 0.040 and a typical installed density of 50 kg/m³ for rock fibre and 25 kg/m³ for glass fibre.

Expanded polystyrene beads and granules

With this system, the polystyrene is used in the form virgin pre-formed bead or as a recovered expanded bead or granule with individual diameters from 1-7mm. It is used either as a loose fill or combined with a binding agent at the time of injection. Manufacture and installation are covered by the relevant BBA certificates for the systems.

A nominal k-value of 0.040 can be expected with this material and a typical installed density of 15 kg/m³.

It should be noted that, in contact with unsheathed electrical cables, the insulant will accelerate the loss of plasticiser from PVC insulation eventually making them brittle.

Fire and water

All the systems are resistant to water penetration, but none constitutes a water vapour barrier. Water penetration across an unfilled cavity is illustrated at right. (Illustration courtesy of the BRE).

Foam does not burn but tends to shrivel and char when exposed to fire. It complies with Class P (not easily ignitable) of BS476: 1968 Part 5. Blown mineral fibres are non-combustible under BS476 Part 4: 1970. The expanded polystyrene systems are combustible under BS476 Part 4: 1970, but the fire resistance of the wall is unaffected by its inclusion.

Dry lining

An alternative approach to the insulation of external walls is to dry line them. This consists of putting a further insulating layer inside a room between the 'living space' and the inner leaf of the wall. This is normally made from insulating board battened to the wall, with either an air gap or insulating material filling the battening.

If interior refurbishment is being carried out, this may well be an attractive method of insulation offering design possibilities and the use of different textures and materials on the wall surfaces. It also does not require specialist insulation contractors, being more in the mainstream of building work. Services and unsightly substrates can be effectively hidden behind the boarding.

However, since the work is carried out inside the room, the available living and working area is reduced and in some commercial premises like offices this may sometimes be unwelcome.

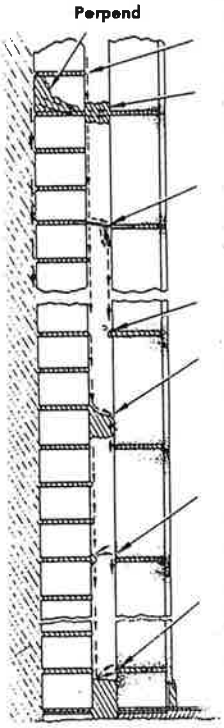
External wall insulation

In renovation programmes on older, single-skin properties, weather resistance (or lack of it) and deterioration of the structure are often factors to be considered along with improving the insulation performance. Another common problem is that of condensation and dampness and many buildings of recent construction, eg of no-fines concrete and system-built housing also exhibit these problems. Often, improved insulation standards would alleviate these.

External wall insulation increases the thermal capacity of a structure. Unlike internal linings, the whole structure is insulated and drastic variations in temperature do not occur: the walls warm up and heat is re-radiated, steadily, back into the interior.

External wall insulation systems have been developed to fulfill two functions: they provide thermal insulation and they provide protection against the weather (and can be applied to buildings which have surface defects). In fact they can also perform an aesthetic function in giving unsightly exteriors a face-lift.

In situations where condensation is a problem, the use of these systems on the exterior of the building, reduces the risk. The dewpoint is moved towards the outside of the structure, so that the chance of interstitial condensation is markedly reduced.



External wall insulation is, in most cases, a composite system. That is, a system, made up of three basic components: the fixing, the cladding and the insulant. All this is then covered with a protective, decorative coat.

Several system types are currently available in the UK:

Mineral fibre slab (25-100mm glass or rock) can be mechanically fixed to the wall. A protective wire lathing and render coat is then applied. A thick coat render system is 25 to 60mm of polystyrene, polyurethane, foamed glass or polisocyanurate which is bonded to the wall and/or mechanically fixed. It is reinforced with metal and protected with a thick coat render (BS5262).

A lightweight polymer system consists of 25 to 60mm of polystyrene, polyurethane or polisocyanurate. This is bonded and/or mechanically fixed and then reinforced with fibrous mesh. The whole is then protected with a polymer scratch coat and finishing coat — usually 3-10mm of each.

Lightweight insulting render (usually expanded polystyrene bead incorporated in a cement render) is

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trowelled onto the wall and can be applied to surfaces with uneven characteristics. In this case thicknesses are between 25mm and 30mm. ●

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Advice concerning wall insulation and more information on suppliers of the above systems can be obtained from the National Cavity Insulation Association (NCIA), the External Wall Insulation Association (EWIA) (both of which can be reached at PO Box 12, Haslemere, Surrey GU27 3AN). Both organisations provide advice to end users including lists of member companies. More information on all forms of mineral fibre insulation can be obtained from Eurisol — UK (The Association of British Manufacturers of Minderal Insulating Fibres). Among the Eurisol publications are Insulation Fact Sheets which can be obtained by writing to the Director General at the above address. More information on the use of phenolic foams for thermal insulation is available from the Phenolic Foam Manufacturers Association at 45 Sheen Lane, London SW14.

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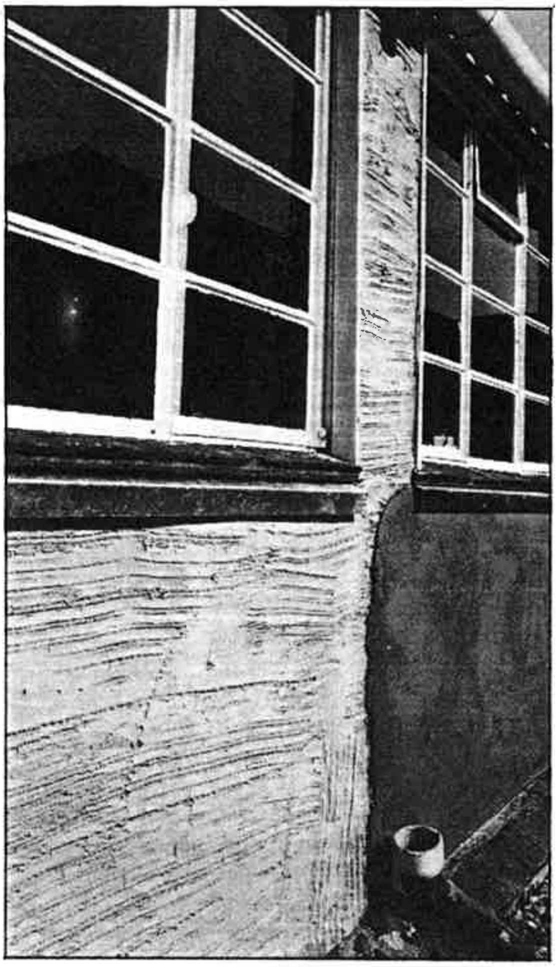

External wall insulation being applied during BRE field trials.