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Built-in cavity wall insulation for housing

A recent amendment to the Building Regulations changed the thermal insulation requirements for housing in England, Wales and Scotland. For external walls, for walls between a dwelling and a ventilated space, walls (or partitions) between a room and a roof space including the space and the roof over that space, the maximum U–value allowed is 0.6 W/m² °C.

Two of the methods used for achieving the thermal requirement are partially or totally filling the cavity by placing insulation boards or batts within the wall cavity as construction proceeds. Correctly installed, they provide economical methods of meeting the Regulations and of reducing the heating costs of buildings.

But care needs to be taken, both in design and construction, to avoid introducing risks of rain penetration and cold bridging; this digest highlights the points that need special consideration by the designer and those responsible for site supervision.

There are some essential differences in bricklaying practices between building partially filled and totally filled cavity walls[1]. Where the practices differ, they are discussed separately in this digest. Other points which require special attention are the same for all built-in cavity fill systems, so these are considered together.

Insulation boards for partially filling the cavity are manufactured from expanded polystyrene bead-board, extruded expanded polystyrene, polyisocyanurate foam, polyurethane foam and glass fibre. Boards are available in 400 mm and 450 mm heights, suitable for fitting between rows of wall ties with metric modular bricks or standard metric bricks (but additional ties are required at openings and the insulation should be trimmed to accommodate them). Partial fill insulation is normally fixed against the cavity face of the inner leaf using either clips attached to the wall ties or independent clips or nails. A number of products have British Board of Agrement (BBA) Certificates; these are assessed as suitable for use with no limitations on exposure rating where wall height is less than 12 m and a cavity of 50 mm or greater is maintained; where the maintained cavity is between 25 mm and 50 mm, use is restricted to lower exposure ratings.

Insulation batts for total cavity fill are made from layers of mineral fibres (either glass or rock fibres) treated with water repellent. Water will not penetrate through the batts but may drain down between the laminations. These batts are available in 405 mm and 455/465 mm heights to suit either metric modular or standard metric bricks. Some products have been assessed by BBA as suitable for any exposure zone in buildings up to 12 m in height.

Design aspects

Weathertightness: partial fill

Where the maintained clear cavity is at least 50 mm, design precautions are essentially similar to those which apply to normal cavity masonry. Care must, of course, be taken to ensure that specification of combined lintels, wall ties, etc, is compatible with the greater overall cavity width.

Products which are certified by BBA for use with clear cavities between 25 mm and 50 mm are subject to certain restrictions on exposure and extra precautions to keep the cavity clean; the top edge of the insulation must be protected by a cavity tray if the insulation does not extend to the full height of the wall, and weep holes should be specified.

In exposed areas where rendering is normal practice, it should still be specified.

BRE tests on rain penetration with various types of insulation[2] have shown that faults potentially leading to rain penetration are similar to those for unfilled cavities (Fig 1), with the addition of further routes if insulation boards are displaced into the cavity (Fig 2). Measurements in partially filled cavities have shown that there will be significantly more debris in maintained cavities narrower than 50 mm than in wider cavities.

To minimise water penetration with partial fills, it is essential that the insulation boards are fixed firmly against the face of the wall. With fixings relying on wall ties, at least four are needed to hold each board securely. Minimum wall tie spacings are therefore 600 mm horizontally and 450 mm vertically. This may be closer than required by structural considerations alone. Boards fixed by nails need at least six per board.

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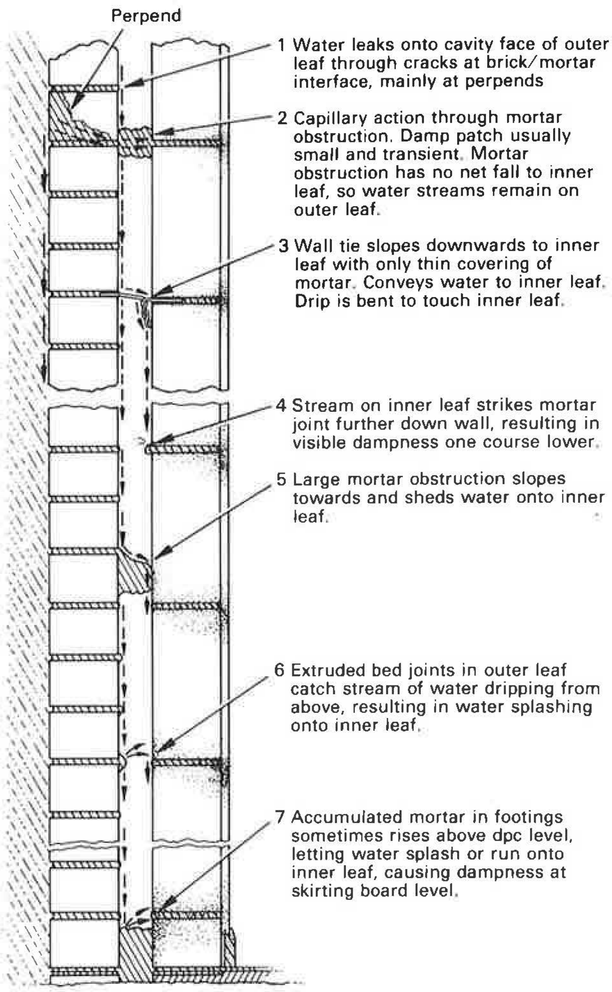


Fig 1 Routes for water penetration across an unfilled cavity

Weathertightness: total fill

Essential principles for total cavity fill are to keep the insulation dry during installation, to keep it free from mortar debris and to design so that any water entering the cavity is directed away from the insulation and the inner leaf. The first two principles are primarily the concern of site staff, and are dealt with later, but the designer must provide workable details which will drain the cavity effectively.

Continuous cavity trays or cavity trays with stopends should be used where openings are close together; if separate trays without stopends are used, water may spill off two adjacent cavity tray ends and flood the narrow pier. Cavity trays should also be specified to protect the top edge of the insulation if it is not taken up to the full height of the wall (for example in gable ends). Where cavity trays are fitted, the usual practice should be followed of leaving some perpends open above the trays to ensure that water can drain away freely. In exposed areas where rendering is normal practice, it should still be specified.

Batt thickness and height can influence the risk of rain penetration: batts too thin for the cavity can slump and if batt heights do not match the vertical spacing of the wall ties, there will be gaps.

Cold bridges: both types of fill

Cavity insulation increases the temperature of the inside surface of external walls and so reduces the risk of condensation. However, higher levels of thermal insulation increases the risk of cold bridges, leading to local surface condensation or pattern staining. Areas which require special care are the ground floor to external wall junction, the roof to wall junction, reveals and lintels. Wall insulation should, therefore, begin below the damp-proof course of the inner leaf and 'overlap' any floor slab insulation. All of the BBA certificated insulations are suitable for installation below the damp-proof course. The cavity should be closed at the wall head by an insulating block (see Digest 270) or the roof insulation should meet the wall insulation; ventilating channels may be used to ensure that ventilation is maintained. Cold bridges at reveals can be reduced by using proprietory cavity closers or by using the frames to close the cavity and insulating right up the vertical dpm. Many types of lintel need extra insulation; if separate lintels are used for each leaf, the cavity insulation is not interrupted.

In Scotland, the maximum permitted U-value in any part of a wall is 1.2; this largely eliminates problems of cold bridges.

Services: both types of fill

Meter boxes, like any other opening, need cavity trays; waste pipes do not.

If combustible insulants are used, it is necessary to fire stop around any penetration of the cavity which might allow access of flame and air in the event of fire (for example, air bricks or thermoplastic pipes). Also, the proximity of combustible insulants to flues may need to be considered. If a flue pipe is serving a Class I appliance, fairly onerous requirements must be met; the relevant Building Regulation is L10, and this

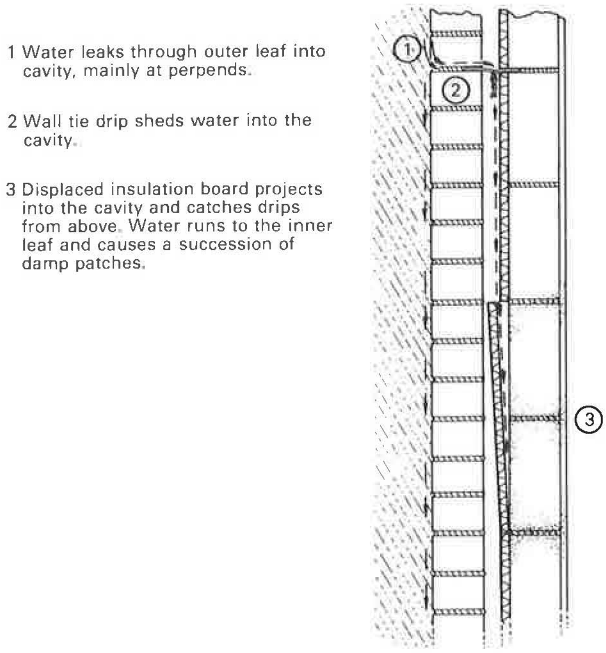


Fig 2 Water penetration route caused by displaced partial cavity insulation

should be consulted at an early stage in the design process. If the flue pipe is serving a Class II appliance, the relevant Clause (L17) is satisfied if no part of the flue pipe is less than 50 mm from any combustible material and, if it passes through a wall, roof, floor, ceiling or partition constructed of combustible materials, it is enclosed in a sleeve of non-combustible material and is separated from the sleeve by an air space of at least 25 mm.

Fire spread: partial fill

A cellular plastics insulating board which does not fill the cavity to its full thickness could, in the unlikely event of its becoming ignited, burn locally and circulate smoke and decomposition products to remote areas. The problem is avoided by providing cavity barriers in accordance with Building Regulations (E14).

Fire spread: total fill

It is unlikely that any significant circulation of combustion products and air is possible through a cavity nominally filled with insulating batts. Active combustion is therefore strictly localised to the point of penetration of the cavity. Whilst the need for fire stopping is less than with the partial fill, sealing the top of the wall is required by the Regulations to limit the extent of air flow and hence of slow or smouldering combustion of the insulation.

Site work

Weathertightness: partial fill

Insulation boards should always be stored flat without bearers or they will warp and it may be difficult to fix them tightly against the wall.

As in an unfilled wall, the cavity of a partially filled wall will keep rainwater from the inner leaf only if there are no paths for water to cross. The usual recommended precautions to prevent mortar and other debris bridging the cavity should be taken, along with special attention to ensure that there are no loose boards within the cavity.

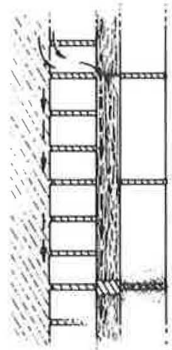
Weathertightness: total fill

Figure 3 shows some of the paths found during the BRE rain penetration tests for rainwater penetration through built-in mineral fibre batt insulations. It can be seen that mortar extrusions from the outer leaf squeezing into the joints between the insulation batts should be avoided, as should the presence of any debris between the batts.

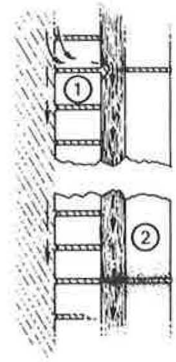
The best way of removing extrusions from the external leaf during bricklaying is to lead with the external leaf so that extrusions can be easily struck from the cavity face (Fig 4). This is standard practice in Scotland but is not common in England, especially above the first lift of brickwork where only an external scaffold is used. In these circumstances, a trough, one brick high, can be built before placing the insulation batts against the inner leaf (Fig 5). The mortar extrusion adjacent to the critical joint between the insulation batts can then easily be struck or smoothed off with a trowel. Troughs should not be deeper than one brick course because mortar might drop on to the horizontal joints between the batts, either during construction or be scraped off the cavity faces as the batts are pushed in. Also, batts become scuffed and distorted if they are pushed into deeper troughs.

To ensure that the insulation is kept in good condition, it should be stored under cover. After installation, it should be covered overnight and during wind and rain to prevent damage.

When small offcuts are used, their laminations should be parallel to the wall or they may present a surface on which water can collect and an easy passage for water to cross the cavity.



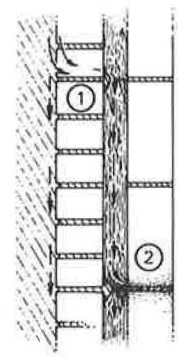
Capillary action through mortar obstructions



1 Water directed into the batts by mortar extruded from facework

2 Any ponding between batts may allow water to reach the inner leaf

Water ponding at horizontal batt joints



1 Water directed into the batts by mortar extruded from facework

2 Mortar obstruction at batt joint compresses batt towards inner leaf. As it flows between laminations, water is pushed closer to the inner leaf. At next batt joint, even slight ponding will allow water to reach inner leaf and cause dampness

Fig 3 Some routes for water penetration across a cavity filled with mineral fibre insulation batts

Cold bridges: both types of fill

It is unusual to find many gaps in built-in cavity fill, but sometimes they occur at lintels, corresponding with cut-courses in the blockwork (especially with mineral fibre batts), at cavity trays (especially with partial cavity fills) and at reveals.

Gaps at reveals are usually due to the insulation being stopped short of the additional ties, to save the small effort involved in trimming the batts or boards to fit around the ties. Another cause is the use of batts or boards with their long axes vertical at narrow piers. This practice should be discouraged because, even if the insulation matches the width between reveals, it will not match the vertical wall tie spacing.

With partial cavity fills, gaps can occur below openings where the fixings are wall-tie dependent, because there is no way of securing the top of the insulation. These gaps can be avoided by using zinc-protected nails for these and any other awkward points.

With partial cavity fill, small gaps due to inaccurate trimming tend to occur around cavity trays if they do not happen to coincide with the joints between the insulation boards.

Gaps in the insulation corresponding with cut-courses in the blockwork occasionally occur where batts are not trimmed to size. Similarly at lintels the batts or boards should be trimmed appropriately to avoid cold bridging.

References

1. HALL B O and FINCH P. Fibre-batt insulation in cavity walls: Site Practice. Building Technology and Management, October 1981, Vol. 19, No. 9.

2. NEWMAN A J, WHITESIDE D and KLOSS P B. Full scale water penetration tests on twelve cavity fills – Part II. Three built-in fills. Building and Environment, Vol. 17, No. 3.

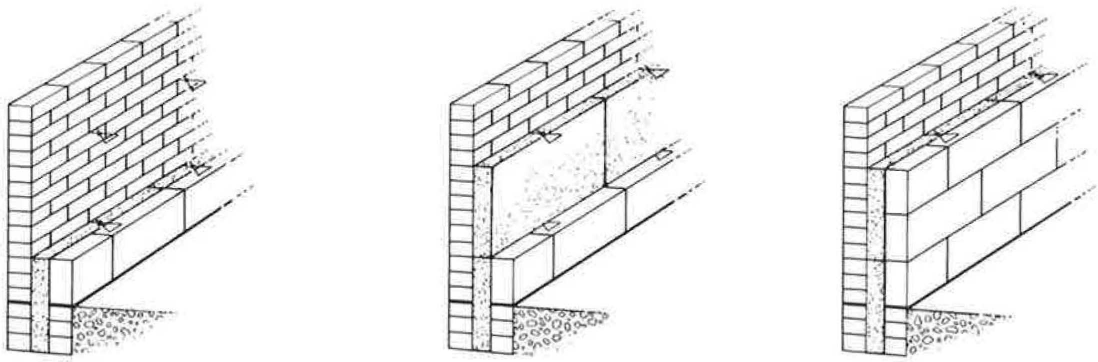


Fig 4 The correct building sequence minimises the amount of mortar left in the cavity.

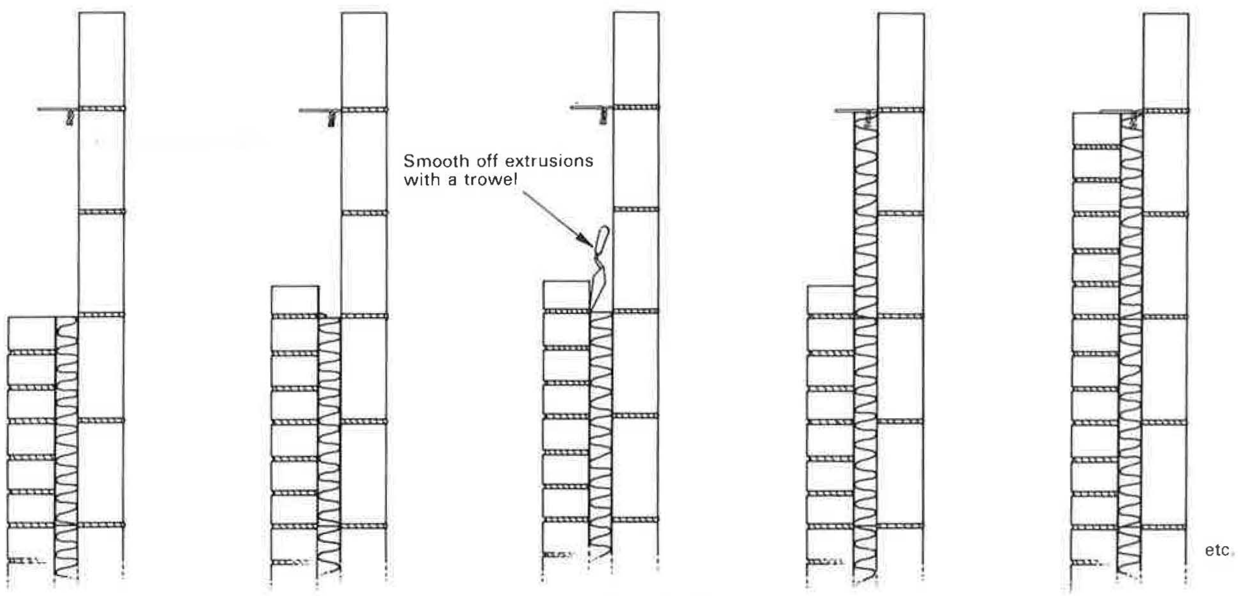


Fig 5 If the blockwork must lead the face work, mortar extrusions from the face work that are opposite horizontal batt joints must be struck or smoothed off, because they are the principal initiators of water penetration. The easiest construction sequence is shown above.

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