CE252

Cavity wall insulation in existing dwellings: A guide for specifiers and advisors

energy saving trust™

Introduction

Our society has become increasingly dependent on fossil fuels such as oil, coal and natural gas. These are finite resources, having been created by natural processes over millions of years. Burning them to produce energy results in emissions of 'greenhouse gases', including carbon dioxide (CO_2). These gases trap solar radiation in the earth's atmosphere and cause undesirable changes in the climate.

Home energy use is responsible for over a quarter of UK carbon dioxide (CO_2) emissions which contribute to climate change. To help mitigate the effects of climate change, the Energy Saving Trust has a range of technical solutions to help UK housing professionals build to higher levels of energy efficiency.

This guide outlines solutions for housing professionals to meet the energy efficiency requirements of level 3 of the Code for Sustainable Homes.

Further details are at:
www.energysavingtrust.org.uk/housing/standards

Cavity wall insulation (CWI) is a key part of the best practice standards relating to wall refurbishment (see Table 1).

Identifying a cavity wall

Cavity walls are built using two skins of brick, or brick and blockwork, with a cavity (gap) in between.

- A brick cavity wall usually has the bricks placed lengthways (stretcher bond).
- The walls are held together using either metal or, more recently, plastic wall ties.

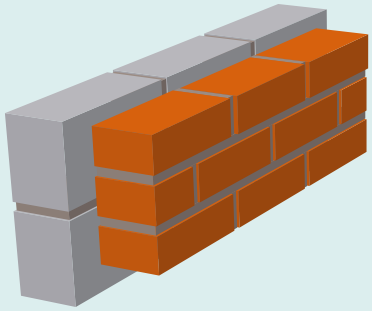

Table 1: Energy Saving Trust refurbishment standard for walls

Exposed element	Best practice refurbishment (W/m^2K)
Walls externally insulated	0.35
Walls internally insulated (including basement walls)	0.35
Walls cavity insulated (including basement walls)	0.55

This guide informs both energy efficiency advisors and specifiers on the various aspects of cavity wall insulation. The guide is divided into two sections that provide:

1 General information to help advisors answer cavity wall insulation questions (page 4).

2 Technical information on the products and the processes of installation (page 6).

Most early cavity wall construction in existing housing generally consists of two leaves of masonry, an outer leaf (often of facing brickwork) and an inner leaf of brickwork or blockwork separated by a nominal 50mm wide cavity. In reality the cavity width varies, with wider cavities giving walls better insulation values and less risk of rain penetration than cavities of 50mm or less. Cavities are typically 65mm wide, but range from about 50mm to more than 85mm.

The majority of existing cavity walls up to 12 metres in height are suitable for cavity fill. Some products are independently certified for use in walls up to 25 metres. Suitability depends mainly on the local exposure to driving rain and the condition of the existing construction. A few buildings above 25 metres in height have been filled following special assessments.

Cavity fill can considerably reduce the heat loss through the walls, giving significant savings in heating costs. The reduction in heat loss may lead to an increase in air temperature in the dwelling and, as a result, more comfortable living conditions. Cavity fill is one of the most cost-effective insulation measures after loft insulation. Occupants can remain in the dwelling during installation as the insulation is pumped into the cavity through the outer masonry leaf and causes little disturbance.

Building regulations

Building regulations for the thermal insulation of walls vary between devolved administrations across the UK. Advice should be sought from the building control at the local authority. For details of the current building regulations for existing dwellings in each part of the UK, see:

England and Wales

The Building Regulations 2000, Conservation of fuel and power, Approved Document L1B – Work in existing dwellings (2006 Edition).

Scotland

Section 6: Energy of the Domestic Technical Handbook on possible ways of complying with the Building (Scotland) Regulations 2004

Northern Ireland

Building Regulations (Northern Ireland) 2006, Technical booklet F, Conservation of fuel and power. Regulations in parts of the UK require walls to be insulated when certain building works are carried out (e.g. rendering). Injecting cavity wall insulation would meet this requirement.

1 Information for energy efficiency advisors

Energy efficiency advisors may be asked questions about cavity wall insulation. Whilst detailed technical queries are best answered by the installer there are some general queries that this section may provide answers to.

What is the current take-up of cavity wall insulation?

Cavity wall insulation is the single most cost-effective, low risk energy efficiency measure available for the existing housing stock, after loft insulation. It can be installed without major disruption to occupants and it needs no maintenance. Yet only around 5 million of the 12 million homes suitable for cavity fill are reaping the benefits of cheaper fuel bills and greater comfort.

This leaves some 7 million dwellings with cavity walls that could still be insulated (CIGA 2002). At the current rate of installation – about 300,000 dwellings per annum – market saturation is some time away. There is no technical reason why this rate could not be increased.

What are the benefits?

In a government sponsored survey in the 1990s (BRE 17/92:1993), people who lived in houses with cavity wall insulation identified the following benefits:

- Reduced fuel bills.
- A warmer house that stays warmer longer.
- Reduced condensation.
- Fewer draughts.
- Benefits to the environment.

Cavity wall insulation can reduce the heat loss through cavity walls by up to 40 per cent. It can also lead to reduced heating costs and improved comfort levels. Payback (savings against costs) times are estimated at between two and three years. About 96 per cent of the occupiers who took part in the survey said they would install cavity wall insulation if they moved house.

The reduced heat losses mean that the internal surfaces of external walls are warmer. This reduces the risk of condensation forming on the walls, but is not a substitute for proper ventilation.

In an unfilled cavity, cold air can move around freely and then enter the building through gaps such as old pipe holes, where joists are built in, or even through the blockwork and behind the plasterboard. Cavity wall insulation reduces the movement of air and so reduces draughts within the home.

But the occupant is not the only potential beneficiary. Installing cavity wall insulation in all suitable existing dwellings would benefit the environment by substantially reducing the emission of greenhouse gases into the atmosphere. Greenhouse gases are widely accepted as causing climate change.

How does filling the cavity affect the wall?

Cavity walls were introduced originally to avoid the problems of dampness experienced by older solid walled dwellings.

Some people think that filling the cavity (in effect bridging the gap between the two masonry leaves of the cavity wall) will lead to a greater risk of dampness passing from the 'wet' outer leaf to the 'dry' inner leaf. In fact, this is not the case, as has been shown by a government sponsored independent study carried out in the mid 1990s (see Figure 1).

There is no evidence from the study that filling the cavity with insulation results in any greater incidence of damp problems than occur in cavity walls that have not been filled with insulation. What the study did show was that the structural condition of the walls is critical in avoiding the transfer of moisture to the inner leaf.

Any cavity wall that is not correctly built, e.g. it has poorly filled mortar joints or mortar droppings on the wall ties, is likely to have problems.

Good construction and continuing maintenance, such as pointing, are therefore key factors in determining whether a wall is suitable for cavity insulation.

The charts in Figure 1 show the improvements associated with cavity fill. There are fewer problems and less condensation and damp. Condensation and damp are most commonly associated with poor ventilation – especially in properties with filled cavities. Occupiers should be advised to maintain some form of controlled ventilation (e.g. trickle vents).

How is a wall's suitability assessed?

To ensure that cavity wall insulation is only installed where it is appropriate, and that the price is accurate, the designers of each cavity wall insulation system have a strict assessment procedure.

This procedure involves:

- Determining whether the wall is in fact a masonry wall with unfilled cavities.
- Inspecting the general condition of the external wall.
- Identifying any constructional defects that first need to be remedied, e.g. failed pointing.
- Checking on the inside of external walls to see if there are any existing dampness problems that need to be remedied.
- Checking any penetrations of the external wall, e.g. for flues and air ventilators.
- Finding out if the cavity of a directly adjacent house has already been filled, e.g. in a terraced or semi-detached house.
- If necessary for the insulation system, checking the exposure of the wall.

Householders/clients should ask potential installers to identify any areas that cannot be insulated, before undertaking the work. If the areas are substantial the householder/client should seek a second opinion.

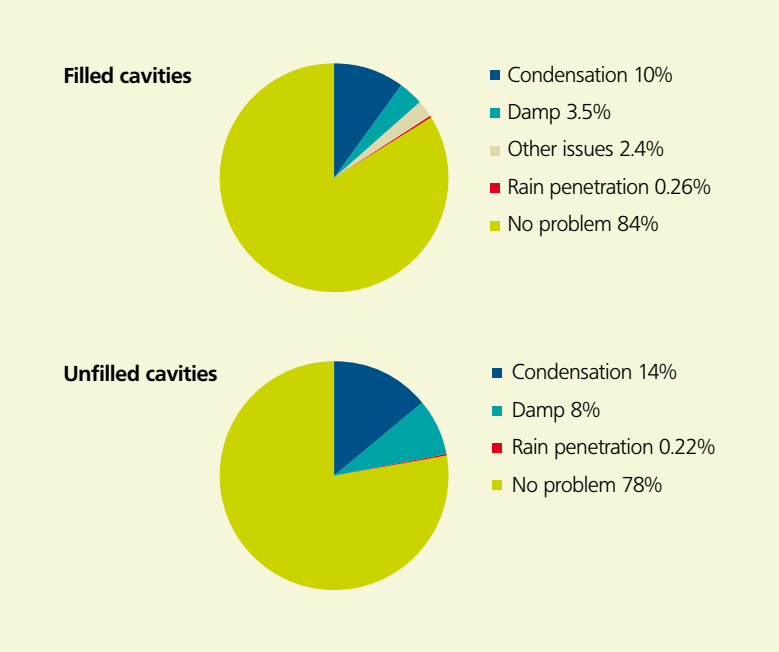

Figure 1: Analysis of rain penetration: No statistical difference between filled and unfilled cavities.

What is involved in filling?

The installation usually takes less than half a day to complete. It is done entirely from the outside so it causes little disturbance compared with other forms of retro-fit wall insulation, such as insulated dry lining. The only discomfort would arise from the noise of drilling the injection holes and injecting the insulant.

The installation process involves:

- Drilling injection holes through mortar joints.
- Installing cavity barriers to prevent the fill entering the cavities of adjacent properties.
- Sleeving (or sealing and replacing, if obsolete) air ventilators that cross the cavity.
- Injecting the fill material into the wall cavity and carrying out quality checks on it.
- Making good the injection holes with colour matching mortar or render.

What is the CIGA guarantee scheme?

Underpinning the work of reputable cavity wall insulation contractors is the CIGA guarantee scheme. This is administered by the Cavity Insulation Guarantee Agency (CIGA), which was established in consultation with the government to provide householders with an independent, uniform and dependable 25 year guarantee.

CIGA is an independent agency, managed by a committee of system designers (the insulation material suppliers) and approved installers, with support from trade associations and the government.

Under the scheme, an approved installer is required to:

- Carry out a pre-installation assessment of the property to determine its suitability.
- Carry out the installation in accordance with approved technical requirements.
- Provide the customer with a guarantee, issued by CIGA, on completion of the contract.

If there is a post-installation problem, the homeowner can contact the approved installer who will inspect and remedy the problem where possible. If the problem is unresolved, the customer can contact CIGA (see Contacts on page 11 for details), who will arrange for the relevant system designer to investigate the complaint and, where necessary, carry out remedial work free of charge.

2 Insulation products and installation

Choice of insulation

The insulants commonly available for cavity fill are blown mineral wool, Urea-formaldehyde foam and bonded polystyrene beads. Two British Standards deal specifically with UF foam: BS 5617 covers material standards and BS 5618 is the Code of Practice for installation. For other systems, only those certified by a UKAS accredited certification body should be used.

Polyurethane foams also improve the thermal insulation of the wall, although they are primarily used for cavity wall reinforcement. They should have independent certification, or be to BS 7457: 1994 standard and be installed in accordance with BS 7456: 1991.

Summary of cavity wall Insulants

Mineral wool

- Glass wool.
- Rock wool (sometimes called Stone wool).

Beads or granules

- Expanded polystyrene (EPS) beads.
- Expanded polystyrene (EPS) granules.
- Polyurethane (PUR) granules.

Foamed insulants

- Urea-formaldehyde (UF).
- Polyurethane (PUR).[1]

There are other materials on the market, such as natural fibre or recycled materials, but they are not commonly available for cavity wall insulation.

Suitability of walls for cavity insulation

Although most traditional cavity walls can be filled, an assessment of each property should always be carried out to determine the suitability of the walls for the cavity fill being considered. Where defects are identified, these should be satisfactorily rectified before work begins. Any dampness problems should be investigated to determine the cause and then remedied.

Methods of assessment are given in BS 8208 and in best practice guides from the Cavity Insulation Guarantee Agency (CIGA), (see Contacts on page 11 for details).

The exposure of the walls to wind-driven rain should be assessed and related to any restriction on the particular type of cavity fill chosen.

Exposure rating

Walls up to 12 metres in height

Beads and mineral wool can be used in any exposure up to 12 metres in height, provided the installation is to the appropriate British Board of Agrément (BBA) or British Standards Institution (BSI) standard, and installed by approved installers.

For guidance on installation UF foam in exposed areas refer to BS 5618.

Buildings on escarpments facing the prevailing wind should be carefully considered. A more accurate estimation of exposure can be determined by referring to BS 8104, BS 5628: Part 3 or the relevant BS for the insulation material being used.

Walls up to 25 metres in height

There are a number of cavity wall insulation certificates for walls up to, and including, 25 metres in height. These contain the following provisos:

- The maximum permitted height of the wall to be insulated is 25 metres.
- From the ground, the maximum height of continuous cavity must not exceed 12 metres.
- The maximum height of continuous cavity above 12 metres from the ground must not exceed 7 metres.
- When calculated using BBA Information Sheet No 10, equation 8, the exposure factor of the building to be insulated must not exceed 120 (this will be assessed by the installer).
- The external masonry facing must not include recessed mortar joints.

BBA Certificate 973361 deals with infill masonry panels in a framed structure and sets out certain conditions, (see Publications on page 11).

1 There have been some concerns about the health effects of urea-formaldehyde cavity wall insulation, although allergic skin reaction to formaldehyde is unlikely at the concentrations used for cavity fill. For more information on this see the local authority circular LAC 37/9 at www.hse.gov.uk

Walls above 25 metres in height
In special cases, independent certification bodies have approved cavity wall insulation in walls above 25 metres in height. Each project has to be assessed by the certification body for suitability before approval is given.

External inspection of the wall

The external leaf of the wall should be in good condition – if it is not any necessary repairs should be undertaken. Cracks in the wall should be carefully inspected by an approved person and the causes ascertained. Cracks may be caused by shrinkage and be easily repaired. Alternatively, they may be due to sulphate attack, ground subsidence or wall tie corrosion. In these cases specialist advice should be sought.

Guidance on inspection, causes and remedies is given in BRE Digests 217, 251, 329, 352 and 359 (see Publications on page 11).

Areas of spalled masonry (caused by frost action or by the crystallisation of salts) should be identified and cured. Where areas are isolated, cavities may be filled after repairs have been made. Properties with widespread spalling are unsuitable for cavity filling and may be best insulated using external insulation. Similar criteria should be applied to spalled or hollow renderings.

Mortar joints should be inspected for excessive cracking of mortar and defective pointing. Any necessary repairs should be made. External walls should be checked for bowing and leaning. Similarly, lintels and windows out of plumb should be identified and the cause rectified.

The cause of any moisture ingress should be identified and repaired, e.g. leaking gutters, downpipes, etc.

Walls painted externally with paints that are impermeable to water vapour may mean that they are unsuitable for cavity fill, in these cases walls should be carefully assessed by the installer prior to any works carried out.

Gaps in the outer leaf at wall heads may need sealing to prevent loss of cavity fill material. This is unlikely to be the case when using mineral wool cavity insulation.

Internal inspection

Damage to internal decoration caused by damp should be investigated and rectified.

If there is any condensation, the cause should be identified and remedial measures taken (see Thermal bridges on page 10).

Dry-lining should be properly sealed and be in good condition. Holes in the inner leaf and open cavities at wall heads may need sealing to prevent ingress of fill into the property. Services, ventilation ducts and flues should be sleeved through both leaves of the wall, and precautions taken to isolate polystyrene and polyurethane insulation from hot flues.

Cavity inspection

The cavity should be continuous. Where bricks have been used as wall ties and to bridge the cavity, as in some older properties, the wall is likely to be unsuitable for filling.

CIGA requires cavities to be at least 50mm wide for them to be eligible for a guarantee. Some systems may have separate approvals for use on cavities less than 50mm. This should be checked with the system supplier before the work is undertaken.

Other defects, e.g. missing wall ties, debris or mortar blocking the cavity, should be identified. If they cannot be remedied, the cavity may be unsuitable for filling.

Supervision and installation

Cavity wall insulation is a specialist job and must be carried out by an approved contractor registered by either BBA or BSI, (see Contacts on page 11). The contractor is normally responsible for assessing whether the walls are suitable for filling.

The installation method varies with the type of system. The principal checks that should be made by supervisors during installation are given below. This is not a comprehensive checklist and reference should be made to the relevant standards for each system – UKAS accredited certification body certificates, documentation prepared by the system supplier and CIGA best practice guides. See 'Further reading and contacts' for more information.

Blown mineral wool

The recommended pattern of injection holes for the system is given in the relevant product approval certificates. The insulant should be blown into each injection hole in turn, starting at one end of an elevation at the bottom of a wall. All the holes in the lowest row of the elevation should be filled, before moving up to the next row.

It should be possible to see the insulant in the fill hole, and to confirm that the insulant falls freely away from the nozzle. Tightly packed insulant at the nozzle may indicate a blockage. The nozzle and hole should be cleared before continuing the filling procedure.

If the filling time is less than normal, the cavity may not be full. The nozzle should be removed and the filling procedure repeated. If the filling time seems very much longer, work should stop and further assessment be carried out.

On completion, the quantity of insulant used should be compared with the estimated quantity. A variation of more than 10 per cent may indicate missed areas, incorrect filling density, or that areas of the structure other than the external cavity may have been filled. If this is the case the following factors may need attention: the density setting on the blowing machine, the density and possible gaps in the fill within the cavity, and the interior of the property to make sure that the fill hasn't entered the dwelling.

Infrared themography can often be used as a quick way of finding gaps in the insulation, but it should be backed up by visual inspection of the cavity before injection holes are made good.

After filling, the following areas should be checked and cleared of any material: air vents, service ducts, venting equipment, chimney flues, combustion air ducts adjacent to the filled cavity, and weep holes.

Beads and granules

EPS beads are spherical with diameters varying from 2mm to 8mm.They are very free flowing and therefore require fewer injection holes through the outer leaf. Granules, being irregular in shape, are less free flowing.

Due to the free flowing nature of EPS beads, particular care must be taken to avoid loss through holes in the inner leaf, around service entry points etc. Beads may be coated with adhesive as they are injected, limiting their escape through cracks and openings.

When the cavity is full, back pressure will stop the flow of beads, at which point the adhesive valve should be closed. It is not necessary to fill gable peaks, unless they form part of a heated living space. If that is the case, the drilling and filling process should be extended to the apex of the gable walls.

Conventionally constructed cavity walls filled with EPS or polyurethane should present no unacceptable fire hazard where the cavity is capped (see page 11). Polystyrene should not come into contact with PVC-coated electric cables to avoid embrittling the cable insulation.

> Care should be taken to ensure that the EPS beads and binding agents are certified for use as cavity wall insulants.

UF foam

UF foam consists of a resin and hardener solution injected with compressed air into the cavity. Injection holes are normally about 1m apart and drilled to a predetermined pattern (see BS 5618).

A closer spacing may be necessary for wider than normal cavities, and the holes in all cases should be at 500mm to 600mm centres immediately above the damp proof course (DPC).

The cavity is filled from the bottom of the wall upwards, using indicator sticks in the adjacent injection holes to show the extent to which the cavity is filled. If an indicator stick fails to move when expected, the reason for this should be investigated. During the filling process, the running conditions of the foam gun should be monitored to maintain quality and efficiency.

After injection, the foam hardens and, as it dries, shrinks leading to fissuring. BS 5617 specifies allowable shrinkage limits and guidance on foam systems that are suitable for cavity fill. UF foam produces formaldehyde vapour as it hardens which may enter the dwelling if the inner leaf is not well sealed. Ventilation of the dwelling will remove any traces of formaldehyde (see page 11).

Polyurethane foam

Polyurethane cavity wall foam consists of thin liquids mixed together and injected into the cavity via 12mm-diameter holes through one leaf of the wall. The mixture expands in the cavity adhering to both leaves. The thermal insulation value of the foam is very good.

Variations in materials and their use

In most of the UK all three main cavity insulation materials – mineral wool (all types), polystyrene beads, and UF foam can be used. However there are small differences between the materials, which can mean that one may be more suited.

Where an installer is unable to carry out an installation, either at all or in part (e.g. leaving out one wall), contractors offering the two alternative materials should be contacted.

Situations where this may occur include:

- Areas of high exposure.
- Buildings over 12m tall (from ground level to apex).
- Storey extensions and conservatories of more than one storey.
- Cavities less than 50mm wide.
- Unusual forms of construction.
- Flats above an unfilled cavity.
- Where the installer is unable to gain safe access.

It should be noted that for some of the above situations the filling of cavities may not be covered by the CIGA guarantee, and customers should consider the situation carefully before agreeing to proceed.

Thermal bridges

By the nature of their construction, traditional cavity walls may have areas where thermal bridges occur. Thermal bridges occur where differences in material thermal conductivities allow heat flow, for example wall ties enable lateral heat to be transferred at a higher rate than the surrounding insulation.

Staining and mould on surfaces around windows can often be caused by damp penetration. Check that there are Damp Proofing Course (DPC) in place and that frames are properly bedded and pointed. If the dampness is being caused by condensation, internal insulation can be applied to the affected parts of the wall.

Condensation is often confined to the reveals adjacent to window frames, in which case an insulated lining to the reveals and soffit is normally sufficient to deal with the problem. If condensation around the windows has been more extensive, insulating the inside face of the lintel, or providing a border of thermal board about 600mm wide around the window opening, may be needed (see Figures 2 and 3).

Sills and the walls under them can also be wetted by condensation running off the windows. Insulating foamed PVC sills, or insulation under the sills and on the walls beneath them, can be used. Condensation can also occur where concrete floor slabs pass through the external wall to support an upper-level wall (Figure 4).

The ceiling can be protected with internal insulation taken back 1000mm from the window. Ideally, the floor above should also be insulated, if this has not already been done for acoustic insulation, but this may prove impractical and expensive.

If the cavity closer at the top of the wall is made of brick, it may cause a thermal bridge. This can be reduced by extending the loft insulation over the wall head, but this may require access via the fascia or soffit board. An alternative might be to fit a deep insulated coving internally (Figure 5).

Whilst the application of internal insulation in selected areas can help to prevent condensation, it may sometimes be visually unacceptable and can cause problems with placing furniture. If possible, the need for additional internal insulation should be assessed using the calculation method in BS 5250.

See BRE Report BR 262 'Thermal insulation: avoiding risks' (listed in Publications on page 11).

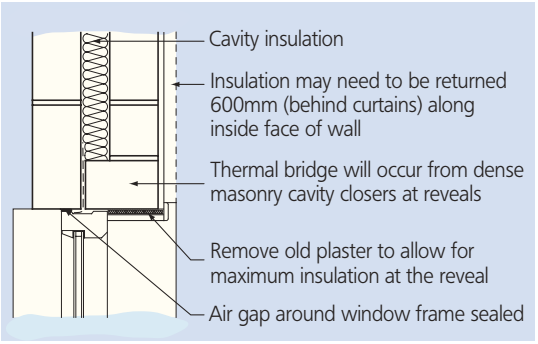

Figure 2 Insulating thermal bridge at reveal

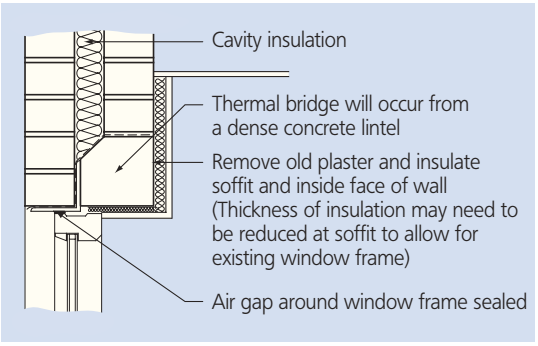

Figure 3 Insulating thermal bridge at lintel

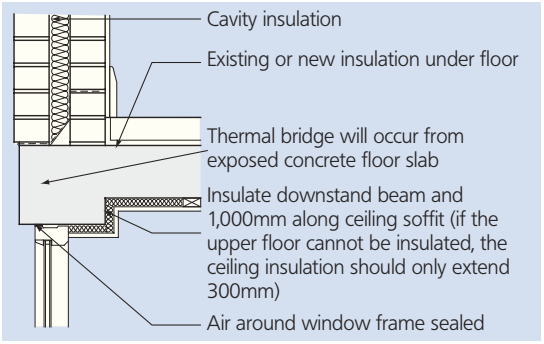

Figure 4 Insulating thermal bridge at floor slab

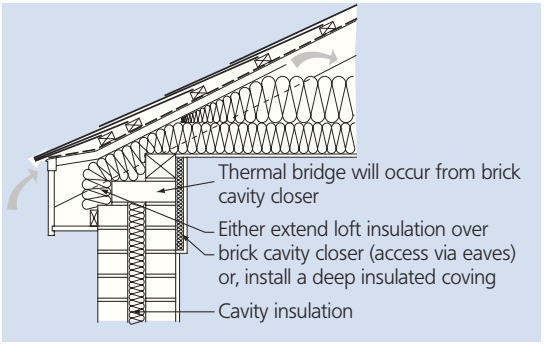

Figure 5 Insulating thermal bridge at eaves

Further reading and contacts

Publications

- Assessing traditional housing for rehabilitation (BR167)
- Thermal insulation: avoiding risks (BR262)
- Brickwork: prevention of sulphate attack (design) (DAS128)
- Wall cladding defects and their diagnosis (Digest 217)
- Cavity insulation (Digest 236)
- Assessment of damage in low-rise buildings with particular reference to progressive foundation movement (Digest 251)
- Fire risk from combustible cavity insulation (Digest 294)
- Installing wall ties in existing construction (Digest 329)
- Underpinning (Digest 352)
- Repairing brickwork (Digest 359)
- Building mortar (Digest 362)
- Urea-formaldehyde foam cavity wall insulation: – Reducing formaldehyde vapour in dwellings (IP 7/84)
- BBA certificate: Blown-in Cavity Wall Insulation 97/3361 walltherm cavity wall insulation for multistorey buildings

British Standards

- BS 5628: 2005: Part 3. Code of Practice for use of masonry and components, design and workmanship
- BS 5617: 1985. Urea-formaldehyde (UF) foam systems suitable for thermal insulation of cavity walls with masonry or concrete inner and outer leaves
- BS 5618: 1985. Code of Practice for the thermal insulation of cavity walls (with masonry or concrete inner and outer leaves) by filling with urea-formaldehyde foam systems
- BS 7456: 1991. Code of Practice for stabilisation and thermal insulation of cavity walls (with masonry or concrete inner and outer leaves) by filling with polyurethane (PUR) foam systems
- BS 7457: 1994. Polyurethane (PUR) foam systems suitable for stabilisation and thermal insulation of cavity walls with masonry or concrete inner and outer leaves
- BS 8104: 1992. Code of Practice for assessing exposure of walls to wind-driven rain
- BS 8208: Part 1: 1985. Guide to assessment of suitability of external cavity walls for filling with thermal insulants
- BS 5250: 1989. Code of Practice for control of condensation in building

To order BSI standards Tel: 020 8996 9001.

Contacts

Energy Saving Trust
Technical helpline on 0845 120 7799
www.energysavingtrust.org.uk/housing

British Board of Agrément
BBA publish a monthly directory which includes a list of approved cavity insulation installers
PO Box 195, Bucknalls Lane, Garston,
Watford WD25 9BA
Tel: 01923 665 300
www.bbacerts.co.uk

British Standards Institution (BSI)
BSI publishes a list of registered contractors for installing UF foam.
389 Chiswick High Road, London W4 4AL
Tel: 020 8996 9000
www.bsonline.bsi-global.com

Cavity Insulation Guarantee Agency (CIGA)
CIGA House, 3 Vimy Court, Vimy Road
Leighton Buzzard, Bedfordshire LU7 1FG
Tel: 01525 853 300
www.ciga.co.uk

UKAS
21-47 High Street, Feltham, MIddlesex TW13 4UN
Tel: +44 (0) 20 8917 8400
www.ukas.com

Further reading

The Energy Saving Trust provides free technical guidance and solutions to help UK housing professionals design, build and refurbish to high levels of energy efficiency. These solutions cover all aspects of energy efficiency in domestic newbuild and renovation. They are made available through the provision of training seminars, downloadable guides, online tools and a dedicated helpline.

The following publications may also be of interest:

- Energy efficient refurbishment of existing housing (2007 edition) (CE83/GPG155)
- Domestic energy efficiency primer (CE101/GPG171)

To obtain these publications or for more information, call 0845 120 7799, email bestpractice@est.org.uk or visit www.est.org.uk/housingbuildings

- Cavity Insulation Guarantee Agency (CIGA): Injected cavity wall insulation - A guide to best practice

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Energy Saving Trust, 21 Dartmouth Street, London SW1H 9BP Tel 0845 120 7799 Fax 0845 120 7789
bestpractice@est.org.uk www.energysavingtrust.org.uk/housing