BRITISH STANDARD

BS 7456:1991

Incorporating Amendment No. 1

Code of practice for

Stabilization and thermal insulation of cavity walls (with masonry or concrete inner and outer leaves) by filling with polyurethane (PUR) foam systems

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics and Rubber Standards Policy Committee (PRM/-) to Technical Committee PRM/72, upon which the following bodies were represented:

Association of Building Component Manufacturers
Brick Development Association
British Board of Agrément
British Plastics Federation
British Rigid Urethane Foam Manufacturers' Association
Calcium Silicate Brick Association Limited
Cavity Foam Bureau
Chief and Assistant Chief Fire Officers' Association
Department of the Environment (Building Research Establishment)
Department of the Environment (Construction Directorate)
Engineering Equipment and Materials Users' Association
Flat Roofing Contractors' Advisory Board
Loss Prevention Council
Ministry of Defence
National Cavity Insulation Association
National Federation of Roofing Contractors
National House-building Council
Phenolic Foam Manufacturers' Association
Polyethylene Foam Insulation Association
Royal Institute of British Architects

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Ceramic Research Ltd.
British Urethane Foam Contractors' Association (BUFCA)
Department of the Environment
Department of the Environment (Property Services Agency)
RAPRA Technology Ltd.

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Foreword

This British Standard has been prepared under the direction of the Plastics and Rubber Standards Policy Committee from a draft prepared by the British Rigid Urethane Foam Manufacturers' Association.

Greater use is being made of insulation in construction as a consequence of changes in building regulations.

The use of polyurethane (PUR) foam provides a means of providing thermal insulation in buildings of cavity wall construction having inner and outer masonry or concrete leaves, as well as providing a method of restoring the integrity of walls where the wall ties have become inoperative due to corrosion. A system of this type was first certified by the Agrément Board in 1975.

This British Standard indicates criteria for the selection of suitable buildings and defines the procedures and precautions to be followed to provide for the satisfactory injection of a PUR foam system into the cavity wall.

The procedural advice and the controls needed on site have been fully detailed.

BS 7457:1994 specifies rigid polyurethane foam systems which are suitable for use as described in this code of practice.

It is recommended that installers have a quality management system complying with the requirements of Part 2 of BS 5750.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

0 Introduction

A suitable polyurethane foam system may be injected into a masonry cavity wall by injecting the liquid polyurethane system through properly spaced holes in the outer leaf. The polyurethane foam system expands in the cavity and sets to become a substantially closed-celled cross-linked rigid polyurethane foam which is strongly adhered to the inner and outer leaves, so that these leaves become bonded together. Such a system comprises an isocyanate, a polyol (an isocyanate reactive resin usually containing two or more hydroxyl groups) and an expanding agent, which is a liquid at normal UK ambient temperatures and is usually incorporated as a liquid into the polyol component. Thus the operation consists on site of continuously mixing the two components correctly and inserting the resultant foam system into the cavity. The expansion results from the vapourization of the expanding agent due to the heat generated by reaction of the polyol and isocyanate. Because the strength of the rigid polyurethane foam is significant the system has been widely used for the restoration of the integrity of cavity walls in which the wall ties have become ineffective due to corrosion. The installed rigid polyurethane foam thus confers two benefits namely insulation and interleaf bonding. Provided that the precautions referred to in this code of practice are followed no hazard should arise during or after installation.

It should be stressed that, while polyurethane foam is a satisfactory replacement for normal metal wall ties, it does not prevent corrosion of existing ties in a wall nor halt the deterioration caused by such corrosion. All installations in walls to deal with corroding wall ties have to be accompanied by a suitable treatment of the existing ties such as removal, isolation (see **A.9**).

1 Scope

This British Standard gives recommendations for the installation of rigid polyurethane (PUR) foam systems complying with BS 7457:1994, which are dispensed on site, to fill cavities of maximum width 150 mm of suitably constructed external walls of maximum continuous cavity height 12 m which have masonry or concrete inner and outer leaves, thereby providing additional thermal insulation to such walls and simultaneously, especially in the case of walls with damaged wall ties, improving their structural integrity.

It defines what are suitably constructed external walls and indicates essential procedures and precautions necessary to optimise the filling process. Walls built of random rubble are not covered by this code.

NOTE The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply.

2.1
cavity

an air space between two leaves of an external wall

2.2
polyurethane foam

the cellular polymer resulting from the reaction of the two components of the foam system, i.e. the isocyanate and polyol components

2.3
polyurethane foam system

a mixture of polyol component and isocyanate component which is to be injected into the cavity wall

2.4
indicator stick

a rod, typically 5 mm in diameter and 250 mm long, inserted through an injection or sight hole in the leaf of a wall into the cavity to monitor the movement of the polyurethane foam in the wall cavity at that point during the filling process

2.5
installation contractor

a company or organization that undertakes the injecting of a suitable polyurethane foam system into wall cavities in order to restore the structural integrity and enhance thermal insulation

2.6
sight hole

an additional hole drilled through either leaf of a wall into the cavity, used only to check that the polyurethane foam system has reached that point in the cavity

2.7
unit area plan

a method of dividing up the exterior walls of the building to show the sequence of foaming through the injection holes

2.8
cavity closer

a building feature closing a cavity around an opening in the wall

NOTE Examples are a sill or a lintel.

2.9
stop-end

a vertical cavity closer, such as a reveal block, which limits the horizontal travel of a polyurethane foam system during injection

2.10
cream time

the time taken after the polyurethane foam system (**2.3**) has been mixed for visible expansion to commence

2.11
end of rise time

the time taken after the polyurethane foam system (**2.3**) has been mixed for the foam expansion to be visibly completed

2.12
tack free time

the time taken after the polyurethane foam system (**2.3**) has been mixed for the surface of the expanded polyurethane foam not to adhere to the test stick

2.13
cavity brush

a device introduced into a wall cavity to provide a barrier to the movement of the polyurethane foam

3 Suitability of cavity walls

3.1 General

It is essential that only if the installation contractor (**2.5**) considers the building to be suitable or capable of being made suitable, should installation be carried out (see **3.2**). Rectification of any defects should be carried out beforehand or form part of the contract.

3.2 Determination of suitability

All the aspects in BS 8208-1 should be taken into account when assessing the general suitability of cavity walls for insulation. In particular in this standard points of significance regarding suitability have been detailed in Appendix A.

It is also essential that a survey document be prepared to record the results of the survey to be carried out which should include the following:

a) a study of all relevant drawings, if available, concerning the building structure;

b) identification of any gaps which will allow the polyurethane foam system to escape from the cavity (e.g. gaps around windows, skirting boards and at the top of cavities);

c) an inspection of the cavities using a borescope to assess the following:

1) the general condition of the cavity (see **A.2.5**);

2) the presence of any efflorescence;

3) the condition of damp-proof courses;

4) the failure of (and likely mode of failure of) any wall ties;

5) the necessity to remove wall ties (see **A.9**);

6) the positions of flues or other services present (e.g. electrical cables) (see **A.7**);

7) whether a vapour barrier has been installed on the inner face of the outer leaf, since if such a vapour barrier is present foam should not be installed. In the case of a new construction allowance should be made for this in the design of the building;

8) the need to remove debris (see clause **6**);

9) whether the cavities have been closed at the top (see **A.3**);

10) the presence and location of any flues which need protection by applying non-combustible thermal insulation to prevent the polyurethane foam from coming into contact with the flue material (see **A.2.6** and Appendix B).

4 Polyurethane foam system

It is essential that the polyurethane foam system used in the filling process complies with BS 7457:1994.

5 Thermal performance of installed polyurethane foam

The thermal conductivity value used for design purposes should take into account the limited diffusion of gases that can take place in the foam with time. Generally this will be higher than or equal to the 30 day value. Additional information on this recommendation is contained in Annex A of BS 7457:1994.

6 Pre-installation preparation of the building

Carry out any rectification identified as necessary under **3.2**. It is essential that cavities should be cleared by opening up at intervals along the damp course and above lintels and reveals.

Debris should be removed, if necessary, from the cavity to a depth of 150 mm below the damp proof course. Any water should also be removed.

It is also necessary to ensure that the following checks are carried out.

a) All combustion appliances with flues against, through or adjacent to a cavity wall that is to be filled are to be operated to observe their performance prior to injection of the polyurethane foam system.

b) The position and purpose of all flues and vents are to be noted so that a proper drilling and injection pattern can be planned for the building.

c) Holes in the cavity wall, especially in the inner leaf, are effectively sealed (for example with mortar) to limit the entry of the foam system or any vapours into the occupiable parts of the building.

d) Vents are sleeved using a non-combustible material to maintain facilities for air flow to (e.g. sub floor areas, larders, roof spaces, toilets, bathrooms) permanently ventilated areas.

e) Means are provided at the junction of party walls to prevent spillage of polyurethane foam system into the wall cavity of the adjoining property, e.g. by the installation of cavity brushes (**2.13**).

f) If the window or door frames cross the cavity, that they are braced prior to installation of the polyurethane foam system to prevent distortion occurring.

g) Cavities are closed at the top with a non-combustible material if possible.

Provided that all the checks detailed in a) to g) have been made and appropriate rectification effected where necessary, there will be no vapour hazard either during or after installation. Tests have shown that the occupational exposure limits (OEL)[1)] for vapours of MDI[2)] have never yet been exceeded within a building or outside a building during or after installation.

7 Filling process

7.1 General

Rigid polyurethane foam is formed by reacting as two components an isocyanate with a polyhydroxyl compound containing an expanding agent, catalysts and other additives. The liquid components are mixed in a hand gun and injected into the cavity wall through a series of holes, drilled in a predetermined pattern in the wall. The liquid mixture reacts in the cavity producing a cellular polymer which hardens into a rigid foam bonding strongly to inner and outer leaves of the cavity wall.

NOTE Because polyurethane foam can be difficult to remove when hardened any spillage should be cleaned up as soon as possible.

7.2 Storage

Both the polyol component and the isocyanate component will have finite shelf lives, specified by the supplier or chemical manufacturer. It is essential that the supplier's or manufacturer's recommendations are followed and the shelf lives are not exceeded (see BS 7457:1994).

7.3 Polyurethane foam dispensing equipment

The equipment used to mix and dispense the foam system should be capable of being adjusted to enable foam which complies with the requirements of BS 7457:1994 to be produced. The equipment should be capable of maintaining the temperature of both the polyol and isocyanate components at temperatures prescribed by the polyurethane foam system supplier, throughout the installation of the polyurethane foam system into the cavity.

7.4 Polyurethane foam quality checks

It is essential that the operator should produce samples of polyurethane foam at least once in the working day and for each building being insulated. Samples should be taken when work is commenced, when operating conditions have been established, after equipment is adjusted, and when there is reason to suspect any fault in, or malfunction of, the equipment.

The samples should be suitable for carrying out the quality control tests for appearance, effective density and reaction profile, i.e. cream time (**2.10**), end of rise time (**2.11**) and tack free time (**2.12**) as specified in Table 3 of BS 7457:1994. The tests should be carried out on site, prior to or during installation, by the installation contractor who should monitor the on-site operations.

[1)] OEL's are defined by the Health and Safety Executive who provide information on the toxicity and use of isocyanates in Guidance Note EH 16 and define an appropriate method for determining aromatic isocyanates in air in document MDHS 49.
[2)] Methylene *bis* (4-phenylisocyanate) (MDI) which is one of the two components of the foam system.

In addition it is essential that samples produced on site from each building each day, should be retained for at least 12 months to check their appearance.

7.5 Pre-installation building checks

Access to the building for internal checks is essential prior to, during and after installation. The installation technician should confirm the assessment of the suitability of the building (see **3.2**).

8 Installation of the polyurethane foam system

To avoid the production of excessive amounts of rubble in the cavity, which could lead to bridging, pure percussion drills without rotary cutting action should not be used.

NOTE Bridging is the term used to describe the situation in which an amount of rubble builds up in the cavity at one point such that the inner and outer leaves are effectively no longer isolated by the cavity space.

8.1 Drilling

8.1.1 The objectives of a correct hole pattern are as follows:

a) to ensure that the polyurethane foam system reaches all parts of the cavity to be filled;

b) to ensure that the polyurethane foam system does not penetrate areas of the building where its presence could be deleterious;

c) to avoid over-pressurization of the cavity which could result in structural damage;

d) to ensure that the polyurethane foam system is not pumped into any one injection point for longer than its cream time.

To satisfy items a) to d) injection holes should be spaced not greater than 0.45 m apart (see Figure 1). If the cavity is wider than normal or if the polyurethane foam system cream time is short a closer drilling pattern may be required.

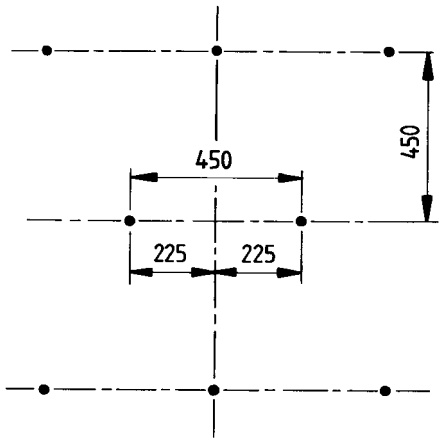
8.1.2 A hole pattern, as shown in Figure 1, should be used except where special conditions apply as detailed in items a) to c). Distances between holes need not be exact and on fair-faced masonry they should be reduced as necessary to bring the hole into the nearest mortar line.

The pattern should be modified in areas near to various building features of the wall. The most important pattern variations occur near the following features.

a) *Horizontal damp proof course*. The polyurethane foam should extend to at least 150 mm below the damp proof course.

b) *Wall openings*. To avoid leaving any gaps in the polyurethane foam around the edge of windows, doorss and ventilators, extra holes may need to be drilled around these areas to ensure that they are completely filled. However, care should be taken to avoid damaging damp proof courses.

c) *Floor or ceiling joists*. The drilling pattern should be designed to avoid having a row of injection holes at the same level as ceiling joists or staircase support timbers in order to minimize the intrusion of the polyurethane foam into the building via faults in the inner leaf.



All dimensions are in millimetres.

Figure 1 — Staggered drilling pattern (representing maximum spacing)

8.2 Sight holes

Sight holes should be used to ensure that the polyurethane foam system does not spread into undesirable areas, and to avoid over-pressurization, in the following areas.

a) *Party wall*. When dealing with the dividing line of an attached property which is not being insulated it is essential to leave a vertical boundary of polyurethane foam adjacent to the neighbouring cavity, so that water running down the untreated cavity will not collect at any point on the edge of the filled area. This is best assured by the installation of suitable cavity closure brushes in a vertical line.

b) *Gables*. On gables, no injection holes should be closer than 200 mm to the tiles or the pressure of the expanding polyurethane foam system may lift the tiles.

c) *Chimneys and flues*. Great care is taken to establish the line of the chimney and its position relative to the cavity, and to ensure that the lining is not punctured during the process. Care is required in examining the chimney construction to see if there is any possibility of the flue having been constructed in, or adjacent to, the cavity. In these cases, either sight holes should be drilled on both sides of the flue line, or each side of the flue should be treated in the same way as for a
semi-detached house at a party wall.

d) *Roofs*. Sight holes are used to check the travel of the polyurethane foam system to ensure that it does not interfere with the ventilation of the roof space.

8.3 Foam filling

8.3.1 *Injection sequence*

It is essential that all drilling in each elevation and at least the first metre of adjacent elevations is completed before foaming of that elevation is commenced.

The injection pattern should ensure that, as far as possible, freshly injected polyurethane foam is always keyed into an area of existing foam, thus giving the strongest possible bond. One possible unit area plan (**2.7**) for a typical semi-detached house is shown in Figure 2 in which the areas have been numbered 1, 2 and 3 to show a suitable injection sequence in which they could be tackled.

Foaming along the bottom horizontal rows should start at the end of an elevation or a stop-end (**2.9**) and continue until a stop-end or boundary is reached.

In each of the main sections, injection of foam should proceed on a horizontal front to ensure that no injection hole is missed and that the cavity is filled from the bottom upwards. To prevent voids occurring, injection should commence at a stop-end within the cavity and the injection should continue until the polyurethane foam system reaches the adjacent horizontally and vertically placed holes (see Figure 3).

While injection of the polyurethane foam system is in progress, attention should be paid to the following points.

a) It is essential to use indicator sticks (**2.4**) during injection. These should be placed in the holes at the injection point, to establish the presence of the polyurethane foam system at these holes and, after gelation, removed.

b) Polyurethane foam system should not be injected into a hole for more than its cream time, which should have been previously determined. Injection for a longer time can cause the polyurethane foam to split. If an indicator stick fails to indicate the presence of polyurethane foam when expected, injection should cease and the reason should be determined. The delay could indicate that the polyurethane foam system has penetrated through a fault in the inner leaf. This is particularly important around critical building features such as chimneys.

c) Care should be taken at all times to prevent over-pressurization of the cavity, particularly when the completion of injections is approaching soffit level, gable ends, cavity closers (**2.8**) or untrunked vents.

8.3.2 *Uncapped cavities*

Care should be taken to limit excessive polyurethane foam extrusion above the cavity in order to avoid restriction of the roof space ventilation.

Where a cavity wall extends over a gable end up to the ridge of the roof, it is essential to fill the whole cavity with polyurethane foam right up to the ridge. If the inner leaf extends only to bedroom ceiling level, it is important to ensure that any water which might come through the outer leaf above this point cannot drain down onto the inner face of the polyurethane foam in the cavity [see also **6** g)].

8.3.3 *Wide cavities*

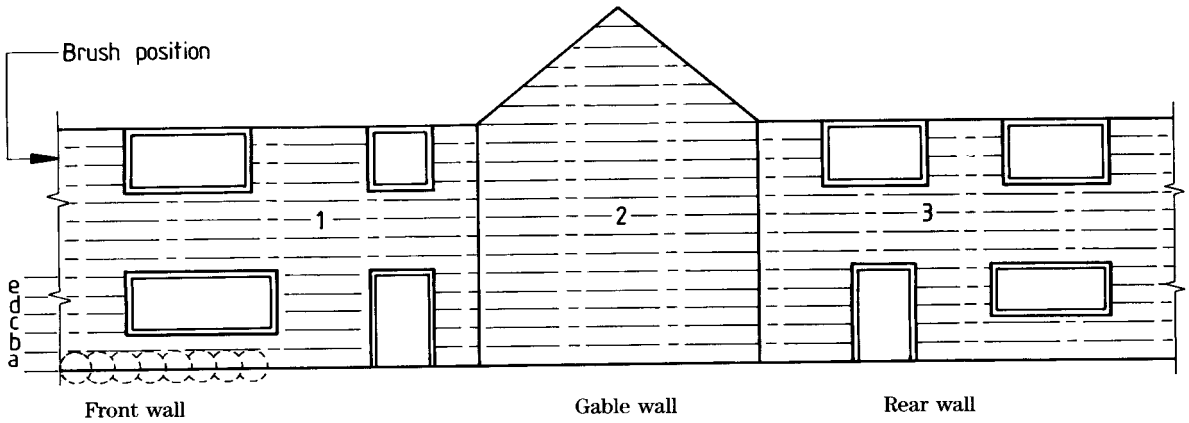
As the cavity width increases it may be necessary to adjust the hole pattern to ensure that the hole to hole injection time does not exceed the polyurethane foam system cream time. It is also essential with wide cavities that the drilling pattern is adjusted to ensure that any horizontal or vertical boundary lines are installed correctly (see **8.1.1**).

8.3.4 *New construction*

It is highly desirable that the cavity should be weathertight, i.e. that the roof is in place and that all cavity openings, such as those around doors and windows, are permanently protected, to avoid water ingress on to the polyurethane foam. It is essential that the walls should comply with BS 5628-3.

9 Post-installation activities

Drill holes should be made good to match the wall finish as closely as possible.



NOTE Injection of foam is undertaken in horizontal bonds, e.g. a, b, c, d, e as indicated, working from left to right at each level.

Figure 2 — Elevations of semi-detached property: unit area plan for injection

The site should be left at least as clean and tidy as it was found.

All chimney flues and combustion air ducts, and air vents with an essential function as part of, or adjacent to, the polyurethane foamed cavity, should be demonstrated as being clear of any blockage. Blocked or partially blocked flues can cause a combustion appliance to malfunction, which could cause lethal fumes to enter the building. Methods of test for flues are given in Appendix D.

CAUTION. *Flues*. There is a slight possibility that a fuel-burning appliance could malfunction after the installation team has left the premises. It is therefore essential for the installation contractor to leave a WARNING CARD with the householder advising him to switch off all such flued appliances should a malfunction be suspected and giving the appropriate emergency telephone number(s).

It is essential that an inspection of the inside of the property is made. Any visible polyurethane foam should be removed from occupiable areas and the hole through which it passed should be effectively sealed.

10 Declaration

It is essential that after the installation the contractor gives a declaration to the client that the installation has been carried out in accordance with BS 7456 with a polyurethane foam system complying with BS 7457:1994 and giving a reference number which designates the system.

11 Records

It is essential that the installation contractor keeps records of every contract at least for the period of legal liability which should include at least the following details:

a) the type of equipment and polyurethane foam system used;

b) the survey record, i.e. the results of the assessment of suitability of the property;

c) the results of the check carried out by the operators on the polyurethane foam system;

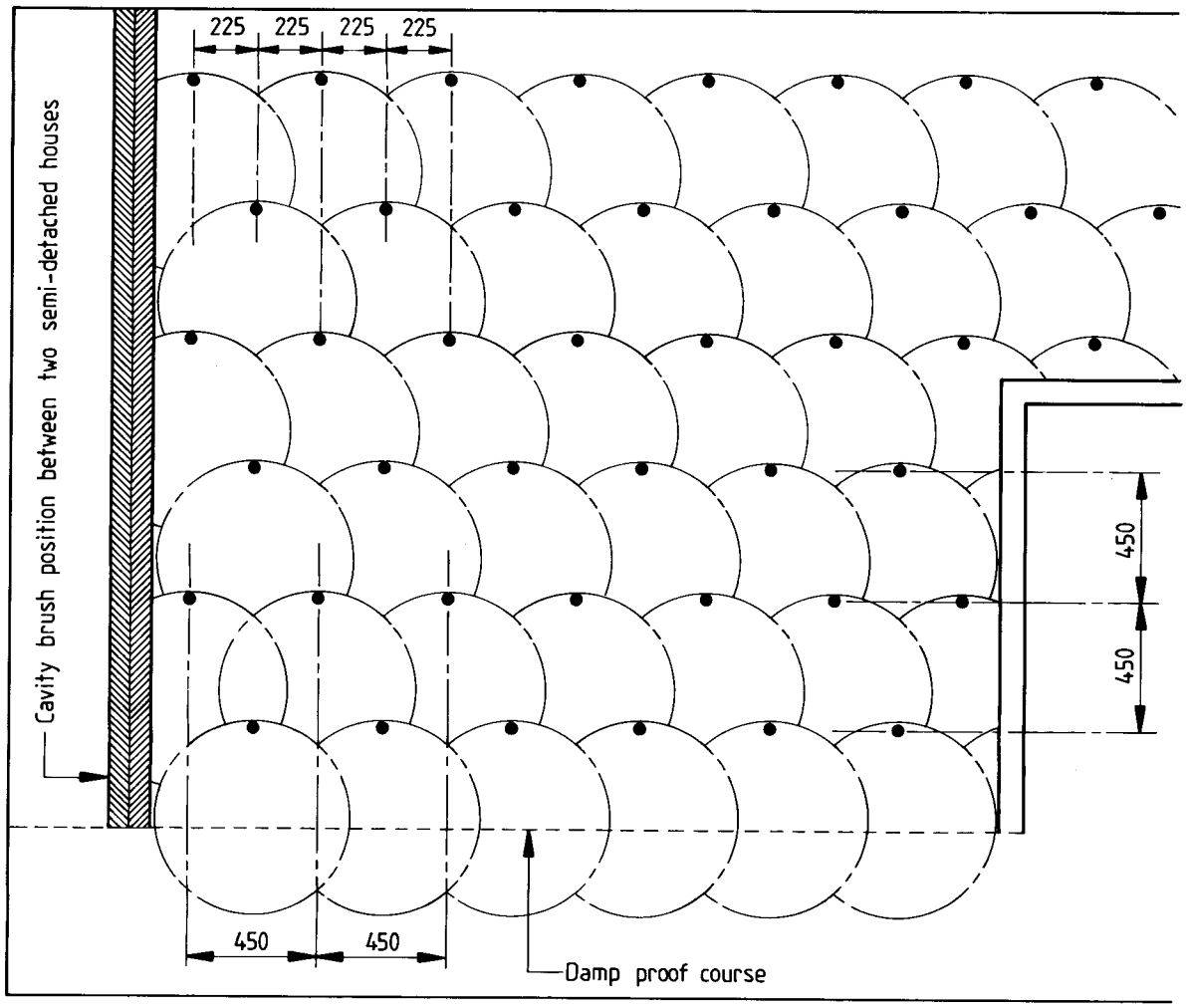
d) the results of the vent and flue checks;

e) the quantities of materials used and suppliers' name and batch numbers;

f) the names of operators carrying out the contract;

g) the job sheet with records of time worked out and weather conditions during the time of working;

h) any difficulties or peculiarities noticed, and action taken during the installation.



All dimensions are in millimetres.

Figure 3 — Overall pattern of filling for a nominal 50 mm wide cavity

Appendix A Criteria of suitability of external cavity walls

A.1 The outer leaf

A.1.1 The outer leaf of areas to be insulated should be of masonry or concrete construction.

A.1.2 If there are visible structural faults, e.g. cracking due to movement or settlement, it is essential that these be reported to the customer and a course of remedial action be taken.

A.1.3 If problems have been encountered with the cavity filling of structures of similar construction or situation, installation should only proceed if it is judged that effective remedies are available.

A.1.4 Where the outer leaf has been covered with a material of very low vapour permeability, e.g. chlorinated rubber paint, the cavity should not be filled.

A.1.5 The outer leaf should be generally sound and weather resistant. Badly eroded pointing, damaged or defective rendering require remedial action to be agreed with the customer. Gaps around frames, unsealed expansion joints, unfilled perpends and small cracks should be made good during the installation.

A.1.6 Where there are parapets it is essential to ensure that water cannot penetrate to the inner face of the polyurethane foam from the exposed inner leaf or coping.

A.1.7 Where there are exposed ring beams or slabs it is essential to ensure that water will not track back along the underside of the beams or slabs.

A.1.8 If the damp-proofing course of the outer leaf is visibly defective then the structure is unsuitable for installation unless prior remedial action has been agreed with the customer and the action carried out.

A.1.9 The survey document should record the positions of all essential vents, flues, chimneys, etc. and of any service entries.

A.2 The inner leaf

A.2.1 The inner leaf of the cavity should be of masonry or concrete construction. If the inner leaf is built of random rubble the whole wall is not covered by this standard.

A.2.2 The cavity should be isolated from the occupiable areas of the building in order to inhibit ingress of the polyurethane foam system as follows.

a) The cavity should be effectively sealed (e.g. with mortar) at any point in the occupiable areas where there is a break in the inner leaf, i.e. where sections of the inner leaf are missing or have been removed.

NOTE The voids above suspended ceilings, rooms in the loft space and the loft space are classed as occupiable areas.

b) Small holes around pipes and cracks around frames within the occupiable areas should be made good as part of the installation procedure.

A.2.3 If there are signs of water penetration or damp to the internal surface other than that caused by condensation, e.g. rising damp or penetrating damp, the cause of the problem should be ascertained and remedies applied or agreed to be applied as part of the contract before proceeding with the installation.

NOTE This should include examination of areas around intentional cavity bridges such as ducts and flues.

A.2.4 If the inner leaf extends only to top floor ceiling level but the wall carries gables or if there are parapets it is important to ensure that any water which may penetrate these features cannot drain onto the inner face of the polyurethane foam in the cavity.

A.2.5 Areas of the inner leaf unsuitable for filling according to this code of practice should be identified on the survey record.

A.2.6 The positions of ducts, flues, chimneys and service entry points should be recorded on the survey document [see **3.2** c) 6) and c) 10)].

A.3 Nature and condition of cavity

A free cavity generally of at least 40 mm width should be available over the areas to be filled.

As cavity width may vary significantly within the wall of a building, cavity width should be confirmed by direct measurement at different points during the drilling operation by method 1 of Appendix E. For an initial survey, an estimation of cavity width will normally suffice estimated by method 2 of Appendix E.

NOTE There is a high risk of mortar bridging the cavity if the cavity width is generally less than 40 mm.

However, a cavity width of less than 40 mm at isolated points is acceptable.

Rat trap bond, or any other use of standard format bricks as wall ties, renders the cavity wall unsuitable for filling.

Cavities capped with concrete gutters should be rejected unless the gutters are watertight.

If the cavity is found to be in excess of 100 mm wide then inspection is required to determine whether there are structural frames within or across the cavity which could cause water penetration problems if polyurethane foam insulation is installed.

If any cavity barriers or stops are known to be present their position should be taken into account in determining the drilling pattern.

A.4 Buildings at the design stage

If it is intended that cavity insulation should be used then the installation contractor should liaise with the designer to ensure that the recommendations of this standard are understood and incorporated.

A.5 Buildings under construction

The installation contractor should liaise with the builder to ensure that the recommendations of this code of practice are fully understood and the building contractor should give the installation contractor the opportunity to inspect the cavity during construction.

NOTE One possible way of meeting this recommendation would be the omission of selected corner bricks.

The installation of the foam should be arranged to suit all parties but should not be before the cavities have been made weather tight.

A.6 Existing structures

The older the building the more likely it is to have been tested by spells of bad weather and any constructional defects will have become apparent. If the building is less than three years old it may be helpful, if possible, to examine the original drawing and it is particularly important to take note of local experience (see **A.1.3**).

A.7 Services in cavity

If it is established that there are pipes or ducts within the cavity then their position should be identified on the survey record to ensure that a drilling pattern can be designed that will not cause damage.

To minimize possible damage to electric cables and other services which may be in the cavity, the fitting of distance pieces to drills ensures that there is not excessive penetration of the bit into the cavity.

NOTE Comparison of the position of features noted on the inner and outer leaf survey records is often helpful on this point.

In cavities insulated with foam all electric wiring should be with either shielded cable or be in conduits and comply with IEE Regulation 522-6 of the 15th edition of Regulations for Electrical Installations, IEE Wiring Regulations.

Electric cables should also be fixed wherever possible in a position and in such a way that they will not be covered by the insulating foam. Where fixing in such a position is impracticable the current carrying capacity of the cable has to be appropriately reduced. For a cable to be totally surrounded by thermally insulating foam, the applicable rating factor may be as low as 0.5.

A.8 Ventilation

Determine which vents are essential to retain, e.g. vents for appliance air supply, fume extraction, room and structure ventilation particularly sub-floor and roof ventilation.

All essential vents connecting to occupiable areas should be trunked and made continuous through both leaves. Other essential vents should be recorded on the survey document to ensure that they are checked after foam installation. Cavity vents should be sealed.

A.9 Wall ties

If wall ties show corrosion, they should be removed from the outer leaf by the appropriate method recommended in Building Research Establishment Digest 329.

The polyurethane foam is permitted to be used in walls which have cracked along the line of corroded wall ties providing that such cracks are repointed prior to filling. The foam should not be used in walls which are severely bowed or distorted.

When used for the purpose of both stabilization and insulation stainless steel anchors installed at one metre horizontal centres at the upper floor level should be installed. If insulation is required only, these measures are not required.

Appendix B Fire performance of polyurethane foam when installed in a wall cavity

Consideration of the fire performance of the cavity structure incorporating rigid polyurethane foam in relation to the possible hazard associated with polyurethane foam, should be assessed using BS 6336 which recommends how fire hazard should be assessed, taking into account the design of the end product and any possible risk to which it might be exposed in use.

Polyurethane foam is an organic material, and hence is combustible. Care should be taken to avoid the possibility of ignition of polyurethane foam because of its high burning rate compared with wood, if exposed, in an enclosure. The contribution to fire growth of polyurethane foam is controlled by the type of finish or facing used in conjunction with the polyurethane foam.

It is generally accepted that insulation contained behind facings of high heat capacity does not have a significant effect on the initial rate of fire growth which is primarily affected by the fire performance of the exposed surface lining. Recent research has indicated[3)] that generally, provided the insulation fully fills the cavity within a masonry wall so that the circulation of air and hot gas is prevented, an effective restriction to fire spread can be achieved.

Installation of cellular plastics insulation has been shown not to detract from the fire resistance of a masonry cavity wall but the polyurethane foam cannot be expected, under fire conditions, to exhibit the load-sharing capability of metallic wall ties.

Care should be taken during installation or repair of any structure or article which contains polyurethane foam to avoid any possible ignition sources.

Appendix C Notes for designers

Text deleted.

Appendix D Flue checks for appliances of rated input not exceeding 60 kW

D.1 General

It is essential that every flue system adjacent to, or in contact with, a wall cavity that has been filled with polyurethane foam is checked after foam installation to ensure that the flue remains clear, and that the combustion products are completely discharged to the outside air. The appropriate methods of inspection and testing for various types of flue system have been taken from BS 5440-1:1990 and are reproduced in **D.2** to **D.7**, with appropriate additions for polyurethane foam installations.

Because of the wide variety of fuel-burning appliance designs, difficulties may arise in establishing whether the flue performance is satisfactory. Should this occur, it is important that the relevant fuel undertaking or appliance maintenance contractor is called in to carry out the appropriate tests.

D.2 Flues where no appliance is fitted

Where practicable, a visible check with the aid of a mirror should be made to see that no foam has entered the flue. If a satisfactory visual inspection cannot be made, a rough check on the efficacy of the flue system should be carried out by a smoke test at each appliance position in turn; all the smoke should be drawn into the flue, and where there is a group of individual flues or a shared flue system, no smoke should issue from any other opening within the building (including the immediately adjoining permises). In certain conditions, there may be spillage of smoke due to inversion caused by the flue being colder than the outside air; in such cases some heat is necessary and the test should be repeated 10 min later.

Smoke may be generated from a smoke pellet, a smoke match or burning newspaper, etc. The first two do not generate heat and, if it is not possible to burn newspaper in the appliance position, the heat from a blow lamp can be passed into the flue opening for 1 min just prior to repeating the smoke test.

D.3 Pre-installation checks where appliances have been fitted

It is essential that each appliance is operated prior to the installation of polyurethane foam to ensure that the flue is functioning correctly. This permits a better comparison of the performance of the appliance before and after polyurethane foam installation, especially the flame appearance where this can be observed. With convector type gas fires check that there are no scorch marks on the outer casing just above the flame enclosure, which would indicate existing flue problems. Where a flue is found to be faulty, installation of polyurethane foam should be delayed until the appropriate remedial action has been taken.

D.4 Post-installation checks of room-sealed appliances

Whenever possible, it should be ascertained visually that the flue and the air inlet are unobstructed.

[3)] Fire performance of combustible insulation in masonry cavity walls. B.F.W Rogowski, *Fire Safety Journal*, 8 (1984–5), 119–134.

A guide to the correctness of the installation is the appearance of the flame in the combustion chamber in comparison with the pre-installation check. A clear, well-defined flame generally denotes that the flue and air-way are unobstructed. (It should be appreciated that the flame of a correctly operating appliance will be dependent upon a fuel being used and the burner.)

Where a flue or duct serves a number of appliances, its performance should be checked against its design predictions by the local fuel supplier.

D.5 Post-installation checks of open-flued appliances

The flue performance with all doors and windows in the room closed is to be checked by carrying out a test for spillage (see **D.7**) at the base of the draught diverter or, in the case of a gas fire, at the canopy. No spillage should occur. If there is an extracting fan in any room of the premises or the particular flat or maisonette concerned, the spillage test is to be carried out with the fan in operation.

NOTE The term fan includes extractor fans, fans in open-flued appliances, fans in cooker hoods and the circulating fans of warm air heating systems.

D.6 Procedure for detecting flue products spillage

Proceed as follows:

a) close all doors and windows in the room containing the appliance, and turn on extractor fans;

b) turn on the appliance;

c) after 5 min carry out a spillage test (see **D.7**).

Momentary spillage should be ignored, but if it is persistent, action is necessary to remedy the situation. Spillage may also be due to inversion, caused by the flue being colder than the outside air; if spillage occurs, the test should be repeated 10 min later.

If the spillage is persistent, obtain expert advice from the fuel supplier.

D.7 Spillage test methods

The presence of combustion products spillage may be detected in one of the following ways.

a) Hold a smoke match so that the flame is approximately 3 mm up inside the lower edge of the draught diverter or the canopy of a gas fire. Spillage is indicated by the smoke being displaced outwards from the draught diverter or canopy.

b) Hold a lighted taper so that the flame is just below the edge of the draught diverter. Spillage is indicated by the flame being displaced outwards from the draught diverter.

c) Hold a piece of cold, polished metal or a mirror close to the lower edge of the draught diverter. Spillage is indicated by the bright surface becoming dimmed by condensation.

d) Direct smoke, e.g. from a smoke puffer, just below the edge of the draught diverter. Spillage is indicated by the smoke being displaced outwards from the draught diverter.

e) Ignite a smoke pellet in the combustion chamber of the appliance and observe whether smoke emerges from the draught diverter. This method is useful when access to the draught diverter is difficult, e.g. where a rear-flue ducted air heater is installed in a compartment.

NOTE In items a) to e) the whole of the draught diverter perimeter or edge of the gas fire canopy should be checked.

Appendix E Methods for determining cavity width

E.1 Principle

The cavity width is obtained by subtracting from the measured distance from the outside of the outside leaf to the cavity side of the inner leaf the thickness of the outer leaf.

E.2 Method 1. Direct measurement

E.2.1 *Apparatus*

E.2.1.1 *Cavity measuring gauge*

E.2.1.2 *Leaf gauge*

E.2.1.3 *Masonry drill*

E.2.2 *Procedure*

Drill a hole normally through the outer surface of the outer leaf large enough to insert the cavity gauge until it makes contact with the cavity side of the inner leaf (see Figure 4). Measure the distance between this contact point and the outside surface of the outer leaf, L, to the nearest millimetre. Insert the leaf gauge to determine the thickness of the outer leaf, T to the nearest millimetre. If the outer leaf has been rendered then this second measurement will include the thickness of rendering.

The cavity width C (in mm) is then calculated as follows:

$$C = L - T$$

where

C is the cavity width (in mm);

L is the distance from the outer surface of the outer leaf to the cavity side of the inner leaf (in mm);

T is the thickness of the outer leaf including any rendering (in mm).

E.3 Method 2. Estimation

Provided the basic materials of construction are known an estimation of cavity width can be obtained by measurement of the overall wall thickness as shown in Figure 4, and the cavity width of adjacent elevations without openings estimated as shown in Figure 5.

NOTE 1 An indication of the thickness of external renders can be obtained where the bottom edge of the render is above ground level.

NOTE 2 A wet plaster finish applied to an inner leaf is normally considered to be 12 mm thick.

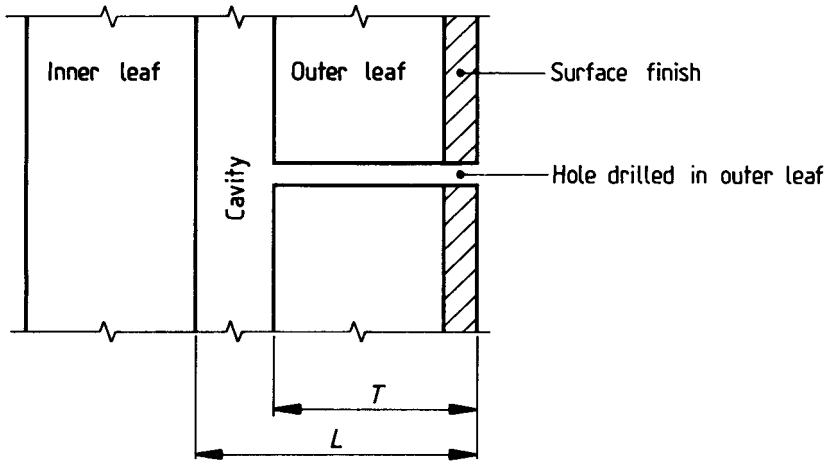


Figure 4 — Measurement of cavity width (see method 1 of Appendix E)

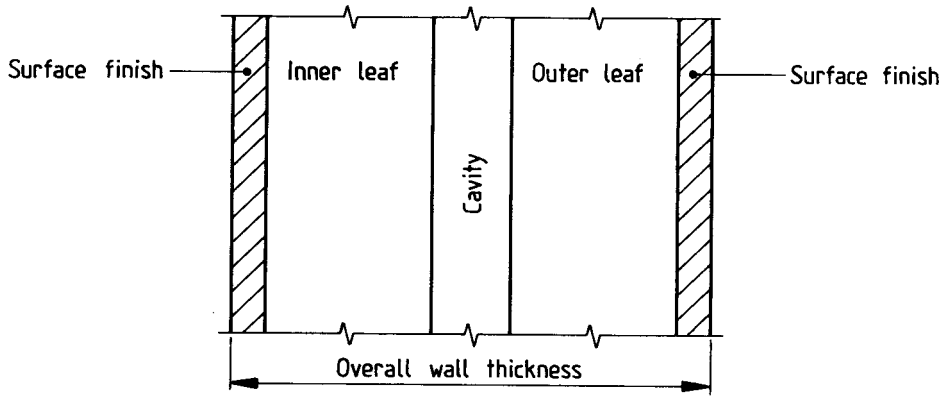


Figure 5 — Estimation of cavity width (see method 2 of Appendix E)

Publication(s) referred to

BS 7457, *Specification for polyurethane (PUR) foam systems suitable for stabilization and thermal insulation of cavity walls with masonry or concrete inner and outer leaves.*

BS 5440, *Installation of flues and ventilation for gas appliances of rated input not exceeding 60 kW (1st and 2nd and 3rd family gases).*

BS 5440-1, *Specification for installation of flues.*

BS 5628, *Code of practice for use of masonry.*

BS 5628-3, *Materials and components, design and workmanship.*

BS 5750, *Quality systems*[4)].

BS 5750-2, *Specification for production and installation.*

BS 6336, *Guide to development and presentation of fire tests and their use in hazard assessment.*

BS 8208, *Guide to assessment of suitability of external cavity walls for filling thermal insulants.*

BS 8208-1, *Existing traditional cavity construction.*

IEE Regulation 522-6 of the 15th edition of Regulations for Electrical Installations, IEE Wiring Regulations[5)].

Building Research Establishment Digest 329 Installing wall ties in existing constructions[6)].

Health and Safety Executive, Guidance Note EH 16 — Toxicity and use of isocyanates[7)].

Health and Safety Executive document MDHS 49: Method for the determination of isocyanate in air[7)].

[4)] Referred to in the foreword only.

[5)] Available from The IEE Publishing Department, Michael Faraday House, 6 Hills Way, Stevenage, Hertfordshire SG1 2AY.

[6)] Available from BRE, Garston, Watford WD2 7JR.

[7)] Available from HMSO, 49 High Holborn, London WC1 for personal callers, or by post from HMSO, P.O. Box 276, London SW8 5DT.

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