BS 7457:1994

Specification for

Polyurethane (PUR) foam systems suitable for stabilization and thermal insulation of cavity walls with masonry or concrete inner and outer leaves

Confirmed
December 2009

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
Department of the Environment (Building Research Establishment)
Department of the Environment (Construction Industries Directorate)
Engineering Equipment and Materials Users' Association
European Phenolic Foam Association
Flat Roofing Contractors' Advisory Board
Ministry of Defence
National Federation of Roofing Contractors
National House-building Council
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)
RAPRA Technology Ltd.

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Contents

Foreword

This British Standard has been prepared under the direction of the Plastics and Rubber Standards Policy Committee. It supersedes BS 7457:1991 which is withdrawn.

This edition introduces technical changes but it does not reflect a full review or revision of the standard. It is envisaged that this standard will be replaced by a European Standard in due course and that the European Standard will be adopted in the BS EN series.

Requirements have been included for the thermal conductivity to be designated by the manufacturer.

The installation of suitable polyurethane foam into the cavities of masonry walls is widely recognized as providing an improvement in their thermal insulation. At the same time the high strength characteristic of the material and its good adhesion to masonry has led to its being widely adopted as an effective method for stabilizing walls in which the wall ties have, by corrosion, become inoperative.

The successful installation of polyurethane foam into external cavity walls relies on two standards, i.e. this standard which specifies the requirements for the polyurethane foam systems, and the code of practice, BS 7456:1991, which gives recommendations designed to achieve the optimum installation of the polyurethane foam systems specified in this standard in masonry or concrete cavity walls.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, 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.

Introduction

A suitable polyurethane foam system may be injected into a masonry cavity wall by injecting the liquid polyurethane foam 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 vaporization 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.

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** of BS 7456:1991).

1 Scope

This British Standard specifies the property requirements, composition, and the production parameters of suitable rigid polyurethane foam (PUR) systems, which are dispensed on site, to fill the 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 damaged wall ties improving their structural integrity.

2 References

2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative reference

This British Standard refers to another publication that provides guidance. The edition of this publication current at the time of issue of this standard is given on the inside back cover, but reference should be made to the latest edition.

3 Definitions

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

3.1
polyurethane foam

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

3.2
polyurethane foam system

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

3.3
isocyanate component

a liquid isocyanate material which when mixed with the polyol component comprises the foam system

3.4
polyol component

a liquid polyhydroxyl compound containing an expanding agent, catalysts and other additives which when mixed with the isocyanate component comprises the foam system

3.5
cavity

an air space between two leaves of an external wall

3.6
effective density

the mass of a specified sample divided by its initial volume using the method described in Annex D

3.7
declaration

the document supplied by the polyurethane foam system supplier to the purchaser or to any authorized testing or approvals organization, containing relevant details for the proper use of the foam system

3.8
end of rise time

the time taken after the polyurethane foam system (**3.2**) has been mixed for the foam expansion to be visibly completed

3.9
cream time

the time taken after the polyurethane foam system (**3.2**) has been mixed for visible expansion to commence

3.10
tack free time

the time taken after the polyurethane foam system (**3.2**) has been mixed for the surface of the expanded polyurethane foam not to adhere to the test stick (see **E.2.4**)

4 Designation of polyurethane foam

The foams shall be designated to indicate their thermal conductivity (see **5.3**).

The designation shall consist of a two component code comprising the following items in the order presented:

a) the number and date of this British Standard;

b) a double digit number to indicate the thermal conductivity selected in accordance with Table 1.

An example of the designation of foam with a thermal conductivity of 0.020 W/(m·K) is as follows:

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5 Property requirements

NOTE The quality of the polyurethane foam depends upon the choice of raw materials and their method of use as declared by the polyurethane foam system supplier.

5.1 Type tests

The polyurethane foam system (**3.2**) shall produce polyurethane foam (**3.1**) which shall meet the property requirements given in Table 2 when prepared in accordance with the foam system supplier's declaration (see **6.2**) and dispensed into a cavity of the appropriate thickness between materials covered by the scope of this specification.

5.2 Quality control tests

NOTE Details of when these tests are to be carried out are given in **7.4** of BS 7456:1991.

The appearance, effective density and reaction profile of the polyurethane foam shall be as given in Table 3.

5.3 Thermal conductivity

Thermal conductivity shall be determined by either method 7A or 7B of BS 4370-2:1993 at a mean temperature of 10 °C, (30 ± 2) days after manufacture. Materials shall be conditioned throughout this period at (23 ± 2) °C and (50 ± 5) % r.h.

NOTE See additional guidance in Annex A concerning the thermal conductivity 3 day values and design value.

Table 1 — Designation codes for thermal conductivity

Thermal conductivity (see **5.3**) W/(m·K)	**Code**
0.015	15
0.016	16
0.017	17
0.018	18
0.019	19
0.020	20
0.021	21
0.022	22
0.023	23
0.024	24
0.025	25
0.026	26
0.027	27
0.028	28
0.029	29
0.030	30
0.031	31
0.032	32

NOTE These values are 30 day values for quality control purposes. For corresponding long term design values the manufacturer's advice should be sought (see Annex A).

6 Processing requirements

6.1 Polyurethane foam system components

The application technique of the two polyurethane foam system components (**3.3** and **3.4**) shall be as declared by the polyurethane foam system supplier, including any storage requirements.

The values of the properties given in Table 4 for the system components shall be declared for each foam system by the system supplier. The component property values shall then conform to the permissible deviations given in Table 4 and associated declared values.

Table 2 — Property requirements: type tests

Physical property	Test requirement	Test method
Minimum compressive strength normal to the major plane of the cavity, kPa		Method 3 of BS 4370-1:1988
	130	On foam from a cavity 50 mm to < 100 mm thick
	115	On foam from a cavity 100 mm to 150 mm thick
Minimum shear strength parallel to the major plane of the cavity, kPa		Method 6 of BS 4370-2:1993
	100	On foam from a cavity 50 mm to < 100 mm thick
	90	On foam from a cavity 100 mm to 150 mm thick
Dimensional stability maximum mean linear change, %		Method 5A of BS 4370-1:1988
Test conditions		Cut the length and width of the test specimen parallel to the major plane of the cavity
24 h at (– 15 ± 2) °C	1	
24 h at (100 ± 2) °C	2	
Maximum water vapour permeability parallel to the foam thickness, ng/(Pa s m)		Method 8 of BS 4370-2:1993 Condition a)
	7	Carry out the test at (38 ± 0.5) °C and (88 ± 2) % r.h. on one face of the test specimen and 0 % r.h. on the other. Cut the cylindrical test specimens (25 ± 5) mm thick such that their plane faces are parallel to the major plane of the foam
Minimum closed cell content, apparent volume %	85	Method 10 of BS 4370-2:1993
Burning characteristics[a] maximum extent of burning, mm	125	BS 4735:1974
Minimum masonry tensile adhesion strength, in kPa, measured for		Annex B
a) aerated concrete;	50	On a foam thickness of 50 mm to < 100 mm thick
b) brick;	30[b]	On a foam thickness of 100 mm to 150 mm thick
c) breeze block		

[a] CAUTION. The small scale laboratory test described in BS 4735:1974 is solely for assistance in monitoring consistency of production and is not for use as a means of assessing the potential fire hazard of a material in use.
[b] Manufacturers often offer systems giving values considerably higher than this value.

Table 3 — Property requirements: quality control tests

Property	Test requirement and permissible deviations	Test method
Appearance	Uniform, fine, cellular structure	Annex C
Effective density, kg/m^3	Target value to be specified by the polyurethane foam systems supplier [see **6.2** c)]	Annex D
Reaction profile, s	To be specified by the polyurethane foam systems supplier [see **6.2** c)]	Annex E

Table 4 — Permissible deviations on declared values for polyurethane foam system components

Property	Permissible deviations on values declared by the supplier	Test method
Polyol component:		
Density, g/l	± 1 %	Measure using a hydrometer conforming to BS 718:1991
Viscosity, Pa s	± 10 %	BS 188:1977
Isocyanate component:		
Density, g/l	± 1 %	Measure using a hydrometer conforming to BS 718:1991
Viscosity, mPa s	± 10 %	BS 188:1977

6.2 Declaration

The polyurethane foam system supplier shall make a declaration (**3.7**) for each polyurethane foam system with respect to the following parameters:

a) the required ratio of the components;

b) any storage limitations;

c) the data required in Table 3 and the values of the properties given in Table 4;

d) the health and safety requirements[1)].

7 Marking

The containers or invoice shall be marked with at least the following information:

a) manufacturer's name or trademark;

b) product designation as given in clause **4**;

c) manufacturer's description and/or product reference.

NOTE Marking BS 7457:1994 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

[1)] Suppliers are reminded of their responsibilities under the Consumer Protection Act, 1987.

Annex A (informative) Notes for designers

In addition to the 30 day maximum thermal conductivity value which forms the specification value for the purposes of this standard, two related maximum thermal conductivity values have practical importance, and should be obtained for the product from the manufacturer as follows:

a) Design value of thermal conductivity. This figure takes into account the limited diffusion of gases which can be used as a basis for user calculations. Generally this will be higher than or equal to the 30 day value.

b) The 3 day value of thermal conductivity. This value is often used in manufacturing control operations, to ensure the quality of product is regularly maintained. Generally it will be lower than or equal to the 30 day value.

Annex B (normative) Method for the determination of masonry adhesion strength

B.1 Principle

The test involves determining the tensile breaking strength of the bond between the polyurethane foam and the masonry unit measured by applying a tensile force to a test specimen comprising two parallel bricks bonded to an intermediate layer of polyurethane, foam.

B.2 Apparatus

B.2.1 *Two masonry units*, e.g. bricks of nominal size 228 mm × 114 mm × 76 mm.

B.2.2 *Mould*, capable of retaining the two masonry units parallel and otherwise as they would be opposed in the cavity wall and 65 mm apart with facilities to enable a rectangular block of polyurethane foam to be created centrally in situ, bonded to the two masonry units.

B.2.3 *Two steel* 100 mm *square plates*, of thickness 6 mm fitted with bosses to provide means of attachment to the tensile testing machine (**B.2.5**).

B.2.4 *Two-component epoxy adhesive*

B.2.5 *Vertical tensile testing machine*, conforming to grade 0.5 of BS 1610-2:1985.

B.2.6 *Polyurethane foam system dispensing equipment*

B.3 Test specimen

A single test specimen shall be prepared where the polyurethane foam is bonded and sandwiched between two masonry units (**B.2.1**).

B.4 Procedure

Prepare the single test specimen in the following manner. Assemble the masonry units (**B.2.1**) in the mould (**B.2.2**). Prepare the polyurethane foam system dispensing equipment (**B.2.6**) for use in accordance with the manufacturer's instructions. Inject the polyurethane foam system to give a final density of 48 kg/m^3. After 30 min remove the test specimen from the mould carefully and condition it at (20 ± 2) °C and (50 ± 5) % r.h. for at least 7 days.

Bond the steel plates (**B.2.3**) to the test specimen using the adhesive (**B.2.4**) in the testing position in the vertical tensile testing machine (**B.2.5**) and allow 8 h to elapse for the adhesive to harden, whilst maintaining the conditioning atmosphere around the test specimen of (20 ± 2) °C and (50 ± 5) % r.h. Apply a tensile force to the specimen by moving the crosshead at a rate of 10 mm/s until the polyurethane foam bond breaks. Record the tensile strength (in kPa) at which the polyurethane foam bond breaks as the masonry adhesive strength.

B.5 Report

The report shall contain at least the following:

a) the description of the polyurethane foam system;

b) the method of test, i.e. Annex B of BS 7457:1994;

c) the date of the test;

d) the masonry adhesion strength (in kPa).

Annex C (normative) Method for the determination of the polyurethane foam appearance

C.1 Principle

A large specimen is prepared under specified conditions and the cellular structure assessed visually.

C.2 Apparatus

C.2.1 *Polyethylene transparent bag*, 1 m deep and 0.4 m wide (when laid flat).

C.2.2 *Polyurethane foam system dispensing equipment*, as in **B.2.6**.

C.3 Test specimen

The test specimen shall be the polyurethane foam filled polyethylene bag (**C.2.1**) bisected by sawing centrally in the 1 m direction.

C.4 Procedure

Prepare the polyurethane foam system dispensing equipment (**C.2.2**) according to the manufacturer's recommendations. Dispense sufficient liquid polyurethane foam system into the base of the bag (**C.2.1**) to fill it at an anticipated density of 32 kg/m^3. Allow this to expand to fill the bag. After 10 min bisect the filled bag by sawing centrally in the 1 m direction and observe if the cellular structure is fine and even.

C.5 Report

The report shall contain at least the following:

a) a description of the polyurethane foam system;

b) the method of test, i.e. Annex C of BS 7457:1994;

c) the date of test;

d) the assessment of appearance.

Annex D (normative) Method for the determination of effective density

D.1 Principle

A test specimen is measured from a specially prepared and specified large mass of the polyurethane foam.

D.2 Apparatus

D.2.1 *Polyethylene transparent bag*, 1 m deep × 0.4 m wide (when laid flat).

D.2.2 *Polyurethane foam system dispensing equipment*, as in **B.2.6**.

D.2.3 *Balance*, accurate to 0.1 g.

D.3 Test specimen

The test specimen shall be a cube of sides 100 mm.

D.4 Procedure

Prepare the polyurethane foam system dispensing equipment (**D.2.2**) for use in accordance with the manufacturer's recommendations. Prepare a bag full of reacted polyurethane foam using the polyethylene bag (**D.2.1**) and foam dispensing equipment (**D.2.2**) in the manner described in **C.4**.

After 30 min prepare by sawing a test specimen (**D.3**) from one of the two halves of the polyurethane foam filled bag. Measure its dimensions by method 1A of of BS 4370-1:1988 and determine the mass M (in g) to the nearest 0.1 g using the balance (**D.2.3**). Calculate the volume of the test specimen V (in mm^3).

D.5 Expression of results

Calculate the effective density (in kg/m^3) using the following expression:

$$\text{effective density} = \frac{M}{V} \times 10^6$$

D.6 Report

The report shall contain at least the following:

a) the description of the polyurethane foam system;

b) the method of test, i.e. Annex D of BS 7457:1994;

c) the date of the test;

d) the effective density (in kg/m^3).

Annex E (normative) Method for the determination of the polyurethane foam system reaction profile

E.1 Principle

In the course of the liquid polyurethane foam system expanding and becoming solid the time for certain events specified for the system to occur is determined since these characterize the system and are generally covered by the description "reaction profile". The reaction profile comprises the cream time (**3.9**), the end of rise time (**3.8**) and the tack free time (**3.10**).

E.2 Apparatus

E.2.1 *Polyethylene transparent bag*, 1 m deep and 0.4 m wide (when laid flat).

E.2.2 *Polyurethane foam system dispensing equipment*, as in **B.2.6**.

E.2.3 *Stop watch*, accurate to 1 s.

E.2.4 *Test stick*, i.e. a dowel rod.

E.3 Test specimen

The test specimen shall be the polyurethane foam filled polyethylene bag (**E.2.1**).

E.4 Procedure

Prepare the polyurethane foam system dispensing equipment (**E.2.2**) in accordance with the manufacturer's instructions. Inject sufficient liquid polyurethane foam system into the bag (**E.2.1**) to fill it at an anticipated density of 32 kg/m^3, and at the moment when the first liquid enters the bag start the stop watch. Record to the nearest 0.5 s the following reaction profile data:

a) cream time (**3.9**);

b) the end of rise time (**3.8**);

c) the tack free time (**3.10**).

E.5 Report

The report shall contain at least the following:

a) a description of the polyurethane foam system;

b) the method of test, i.e. Annex E of BS 7457:1994;

c) the reaction profile data;

d) the date of the test.

List of references

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 188:1977, *Methods for determination of the viscosity of liquids.*

BS 718:1991, *Specification for density hydrometers.*

BS 1610, *Materials testing machines and force verification equipment.*

BS 1610-2:1985, *Specification for the grading of equipment used for the verification of the forces applied by materials testing machines.*

BS 4370, *Methods of test for rigid cellular materials.*

BS 4370-1:1988, *Methods 1 to 5.*

BS 4370-2:1993, *Methods 6 to 10.*

BS 4735:1974, *Laboratory method of test for assessment of the horizontal burning characteristics of specimens no larger than 150 mm × 50 mm × 13 mm (nominal) of cellular plastics and cellular rubber materials when subjected to a small flame.*

Informative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 7456:1991, *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.*

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