BS 8215:1991

Code of practice for

Design and installation of damp-proof courses in masonry construction

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Elements and Components (of Diverse Materials) for Buildings Standards Policy Committee (ECB/-) to Technical Committee ECB/44, upon which the following bodies were represented:

Associated Lead Manufacturers Limited
Association of British Roofing Felt Manufacturers
Association of Jute Spinners and Manufacturers
Autoclaved Aerated Concrete Products Association
Brick Development Association
British Board of Agrement
British Ceramic Research Ltd.
Consumer Policy Committee of BSI
Contract Flooring Association
Copper Development Association
Department of the Environment (Building Research Establishment)
Department of the Environment (Property Services Agency)
Institute of Building Control
Institute of Clerks of Works of Great Britain Inc.
Lead Sheet Association
Local Authority Organizations
Mastic Asphalt Council and Employers' Federation
Natural Slate Quarries Association
Packaging and Industrial Films Association
Royal Institute of British Architects
Royal Institution of Chartered Surveyors
Society of Chemical Industry

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Foreword

This British Standard has been prepared under the direction of the Elements and Components (of Diverse Materials) for Buildings Standards Policy Committee. It supersedes the information contained in Appendix C of BS 743 which is deleted by amendment. It also supersedes clause **10** of section 3 of CP 102: section 1 and section 2 of CP 102 and CP 102 have already been superseded by BS 8102 and the remaining text of CP 102 is to be amended.

This British Standard is intended as a guide to the design and installation of damp-proof courses in masonry constructions covered by BS 5628 which gives general recommendations for the design and construction of brick and block masonry, including materials and components. In BS 5628-1 the following recommendation is given: Designers should pay particular attention to the characteristics of the materials chosen for damp-proof courses. Materials which squeeze out are undesirable in highly stressed walls, and the effect of sliding at the damp-proof course should be considered especially in relation to lateral loading. In general, advice on the resistance to compression, tension, sliding and shear should be sought from the manufacturers of the damp-proof course.

Many of the basic principles in this standard are relevant to other forms of construction.

In drafting this standard it has been assumed that the design will be undertaken by appropriately qualified and experienced designers having regard to the recommendations and calculation methods contained in BS 5628 and that construction will be carried out by trained operatives under the direction of qualified supervisors.

BSI has published draft methods of test for flexural bond strength and short term shear strength and creep deformation of damp-proof courses. These drafts (DD 86-1 and DD 86-2) aim to provide basic data for future performance specifications for damp-proof course materials. A further document, DD 86-3 describes characteristic strengths of damp-proof course materials used in conjunction with designated mortars.

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 14, 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.

1 Scope

This British Standard contains recommendations for the selection, design and installation of damp-proof courses (DPCs) in both solid and cavity masonry constructions: it does not cover the waterproofing of underground structures, such as basements, where water is under hydrostatic pressure (see BS 8102). This standard does not deal with the installation of chemical DPCs (see BS 6576) nor with the control of condensation (see BS 5250) nor with the surface treatment of masonry with water repellents (see BS 6477).

Guidance on basic principles concerning DPCs, their function and their installation in masonry is given in clause **3**.

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

2 Definitions

For the purposes of this British Standard the definitions given in BS 6100-5 apply.

3 Basic principles

Water is the prime cause of deterioration in building materials and constructions and the presence of moisture encourages growth of mould which is injurious to health.

Building Regulations, framed to protect the safety, health and welfare of building occupants, require that buildings be designed to be stable and to ensure that water neither damages the building fabric nor penetrates to the interior where it may constitute a health hazard to occupants.

Ground water can penetrate building fabric from below, rising vertically by capillary action.

Water falling vertically as rain, hail and snow is under a slight head of pressure. It can also, under the influence of the wind, travel obliquely, horizontally, and even vertically upwards.

Residual water also comes under the influence of gravity and thus exerts pressure.

Figure 1 illustrates typical positions in which DPCs may be required: BS 5628-3 should be consulted for further advice.

The function of a DPC is to prevent moisture or water passing from one part of a construction to another.

DPCs should be designed in conjunction with flashings and damp-proof membranes to ensure a continuous barrier. Not only should they form a barrier to the passage of water but they should also deflect such water to the exterior of the building where it can safely drain away.

DPCs should be installed with care. The constructions in which they are installed should have sufficient stability to preclude settlement or lateral movement which may impair the performance of the DPC.

The necessary inclusion of a DPC in masonry construction may materially affect overall structural performance by introducing a plane of weakness. The overall stability of the structure should be considered in relation to the loads imposed upon it by the weight of the construction and by external forces such as wind pressures, thermal and moisture movements (see BS 5628-1 and BS 5628-3).

4 Materials

The materials that should be used to form DPCs in masonry fall into three groups:

a) *flexible materials,* such as sheet lead, sheet copper, bitumen DPC, bitumen/sheet metal composites, polyethylene, bitumen polymer, pitch polymer;

b) *semi-rigid materials,* such as mastic asphalt;

c) *rigid materials,* such as dense bricks and slates, bedded in cement mortar.

DPC materials should comply with the British Standards listed in Table 1. Other materials may also prove suitable for forming DPCs: the specifier should satisfy himself that they have been properly evaluated and found suitable for such use.

See clause **5** for information on the selection of DPC materials.

5 Design

5.1 Exposure conditions

The designer should first determine the degree of exposure, the risk of penetration from any direction (upwards, downwards or horizontally) and the consequences of water penetration.

NOTE DPCs need not be provided where they are not necessary, e.g. above a suitably designed impervious lintel, beneath an impervious sill or continuous coping, or across openings protected by overhanging eaves.

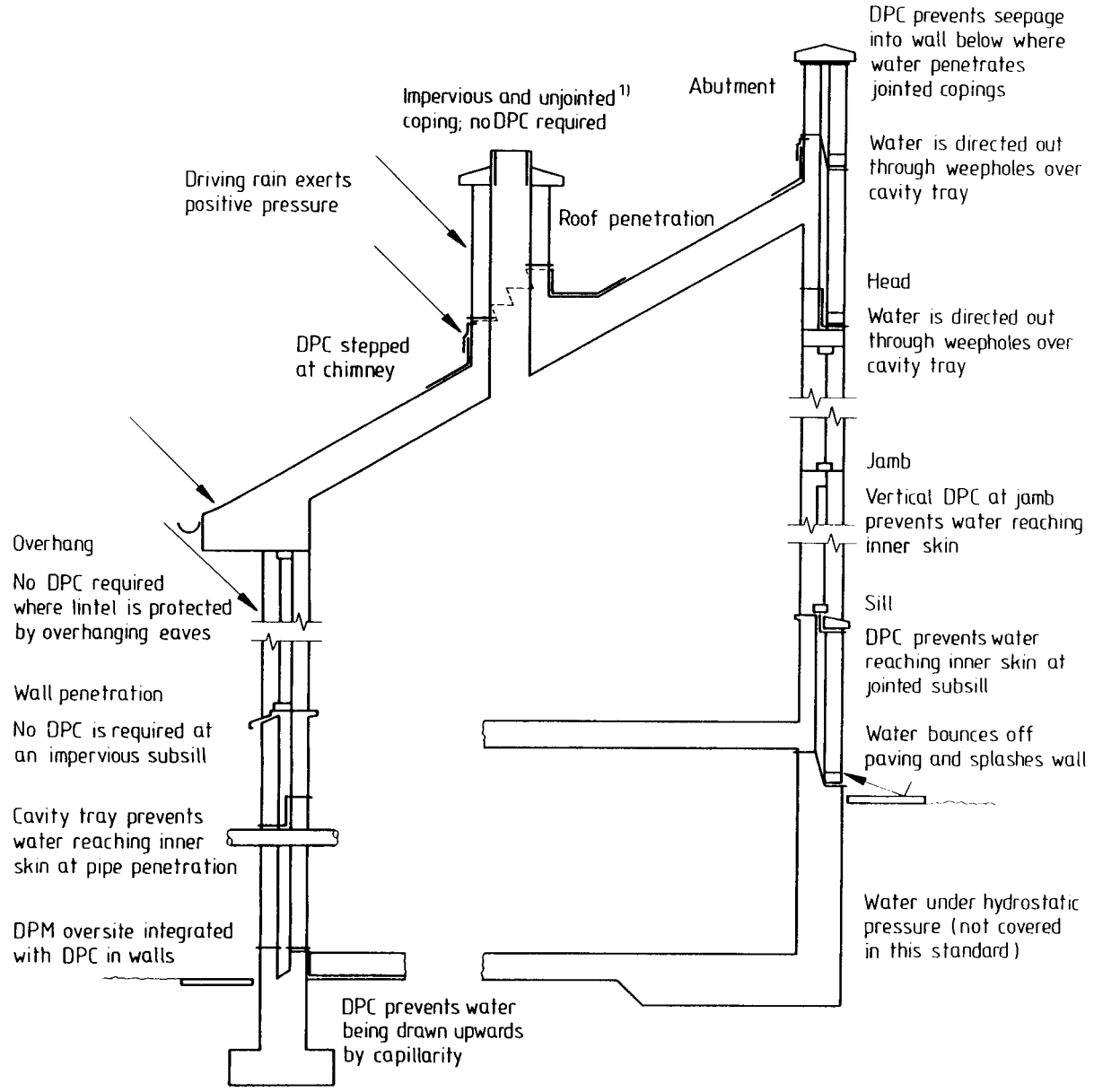
5.2 Primary protection

Careful design, including the provision of weathered copings, sills, overhangs and projections, should provide primary protection which will eliminate or greatly reduce the risk of damage to building fabric and help to prevent water penetration to the interior of the building.

5.3 Integrated design of DPCs

DPCs should be designed in conjunction with membranes and flashings to form a complete system of protection impervious to moisture.

NOTE The preparation of three-dimensional drawings helps to focus attention on critical details and on those junctions which require lapping or sealing: it also identifies areas where it may be advantageous to use prefabricated components.



[1] If jointed, then a DPC is essential.

NOTE. DPM stands for damp-proof membrane.

Figure 1 — Examples of positions where DPCs may be required

Table 1 — British Standards for DPC materials

Number of British Standard	Title	Group or class of material
BS 1178	Specification for milled lead sheet for building purposes	Code 4
BS 2870	Specification for rolled copper and copper alloys: sheet, strip and foil	C 104 or C 106 in the annealed condition (grade 0)
BS 6398	Specification for bitumen damp-proof courses for masonry	A, B, C, D, E or F
BS 6515	Specification for polyethylene damp-proof courses for masonry	Minimum thickness 0.46 mm
BS 6577	Specification for mastic asphalt for building (natural rock asphalt aggregate)	T1418
BS 6925	Specification for mastic asphalt for building and civil engineering (limestone aggregate)	T1097
BS 3921	Specification for clay bricks	DPC1 or DPC2
BS 743	Specification for materials for damp-proof courses (clause **7**. Slates)	Type B

5.4 Location of DPCs

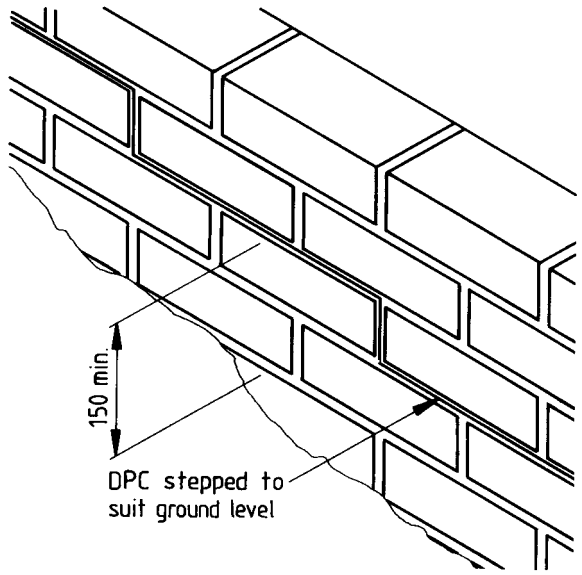
A DPC should be installed in every external wall immediately above ground level to prevent moisture from the ground being drawn up by capillary attraction; in order to guard against rainwater bouncing off the ground and splashing the wall, the DPC should be set not less than 150 mm above the surrounding finished levels adjacent to the wall.

NOTE On sloping sites the DPC may need to be stepped (see Figure 2).

A DPC should be installed beneath sills and copings which are formed with jointed units, e.g. pre-cast concrete or bricks, in order to protect the wall beneath against water penetrating the joints (see Figure 3).

A DPC should be incorporated in a parapet wall or abutment to provide continuity of protection with the roof covering. It should be positioned not less than 150 mm above the roof finish and be set on top of a cover flashing to the roof upstand (see Figure 4).

Where a masonry chimney penetrates a flat or pitched roof or abutment, a DPC should be installed in order to protect the masonry within the building against water soaking down from above (see Figure 5).



Dimension is in millimetres.

Figure 2 — Position of DPC above ground level

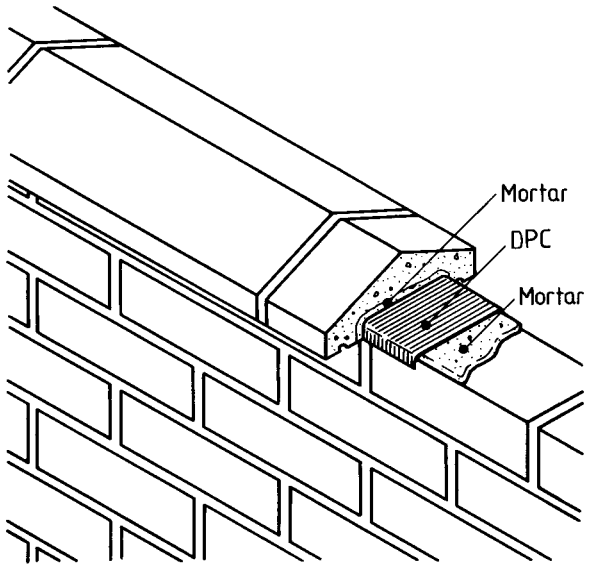
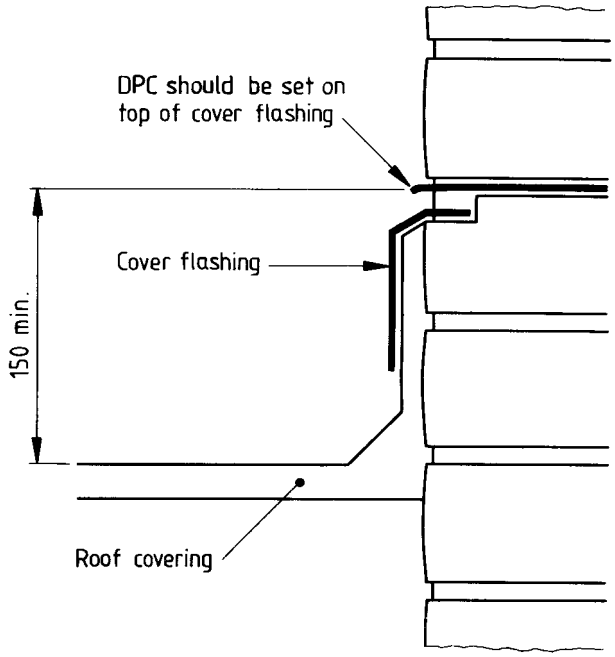


Figure 3 — DPC beneath jointed copings



Dimension is in millimetres.

Figure 4 — DPC in a parapet wall

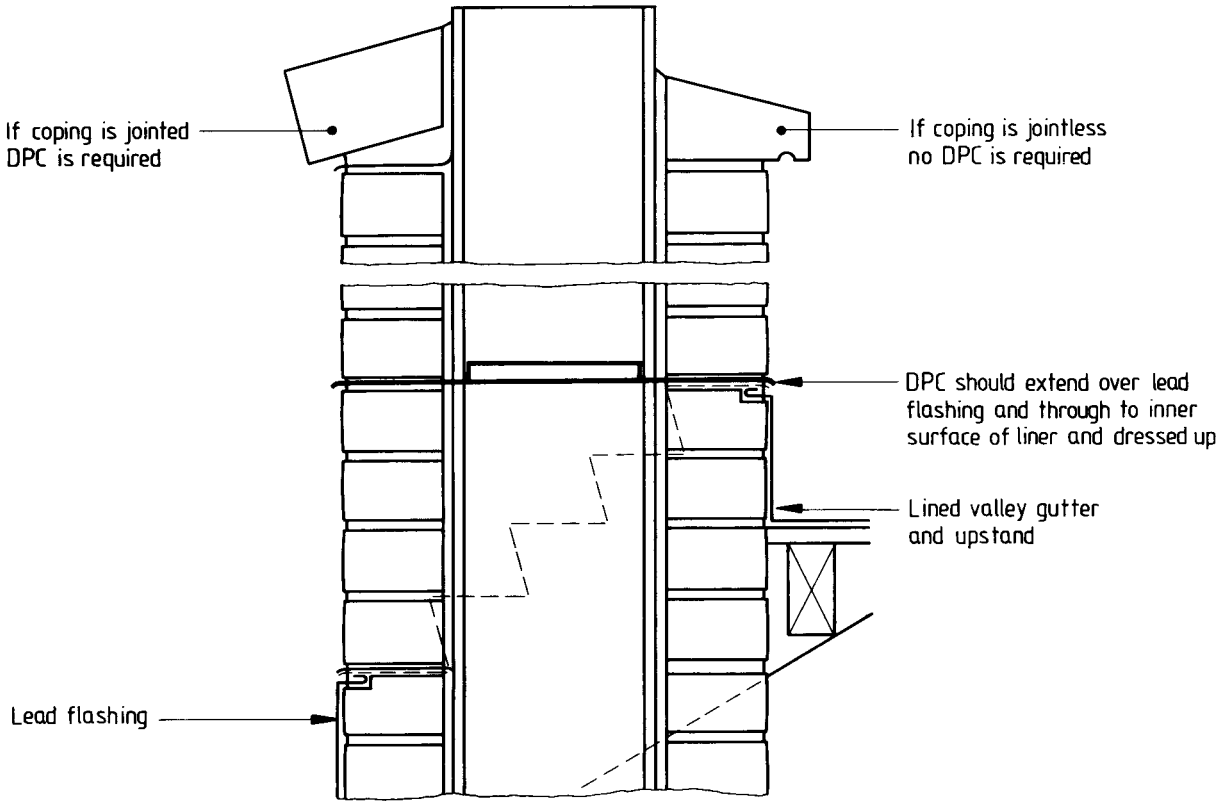


Figure 5 — DPCs in masonry chimney at roof penetration

5.5 DPCs in cavity walling

DPCs in cavity walls should be designed with particular care.

NOTE BS 5628-3 advises that some water will inevitably penetrate the outer masonry leaf of a cavity wall during prolonged periods of wind-driven rain.

It should be assumed that rainwater will run down the inner surface of the outer leaf. Openings in, penetrations through and abutments to a cavity wall should be protected by integrated horizontal and vertical DPCs designed to deflect water away from the inner leaf and allow it to discharge via weepholes.

Forming an effective barrier to damp in cavity walls may give rise to complex three-dimensional details which, it is recommended, are prefabricated.

Horizontal DPCs which bridge a cavity should be stepped up by not less than 150 mm from the outer to the inner leaf. Such DPCs, known as cavity trays, should preferably be formed in one piece; any necessary joints should be fully supported, well lapped and sealed (see Figure 6).

Particular care should be taken in forming changes of direction in cavity trays.

There is a risk of water running off the ends of a discontinuous cavity tray and running back into the construction: a discontinuous cavity tray should be fitted with sealed stop-ends (see Figure 7).

Vertical DPCs should be provided at the jambs of openings in cavity walls: they should be designed to lap under any cavity tray across the head of the opening and to lap over any DPC at sill level so as to discharge water out of the wall (see Figure 8).

Where a cavity wall is partially internal and partially external, protection should be provided to prevent water in the cavity reaching the wall within the building at a lower level. At pitched roof abutments a carefully detailed series of cavity trays, all with stop-ends, or proprietary prefabricated cavity trays as illustrated in Figure 9 should be used.

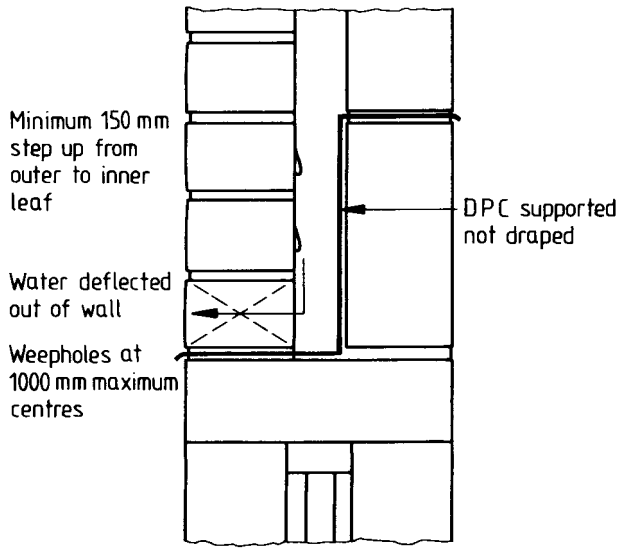


Figure 6 — Principles of cavity tray design

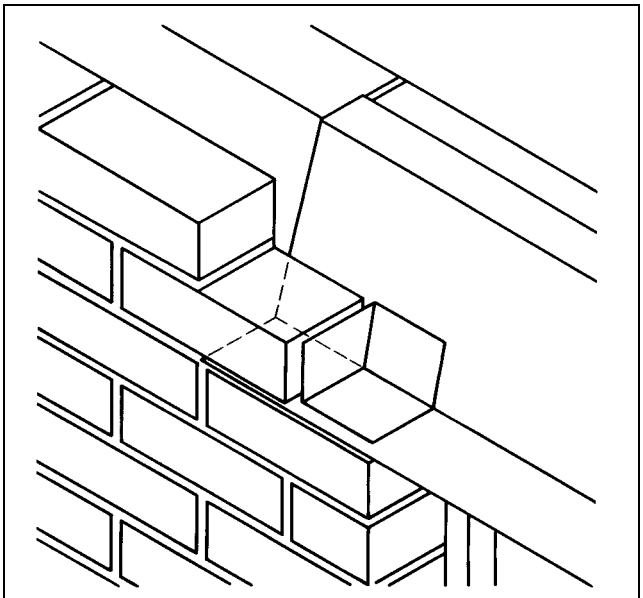


Figure 7 — Sealed stop-ends to a cavity tray

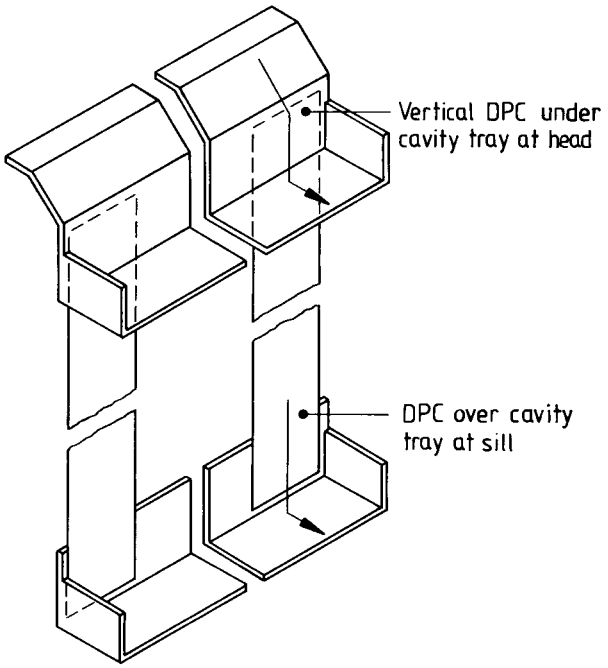


Figure 8 — Co-ordination of DPCs around an opening in a cavity wall (diagrammatic representation of basic principles)

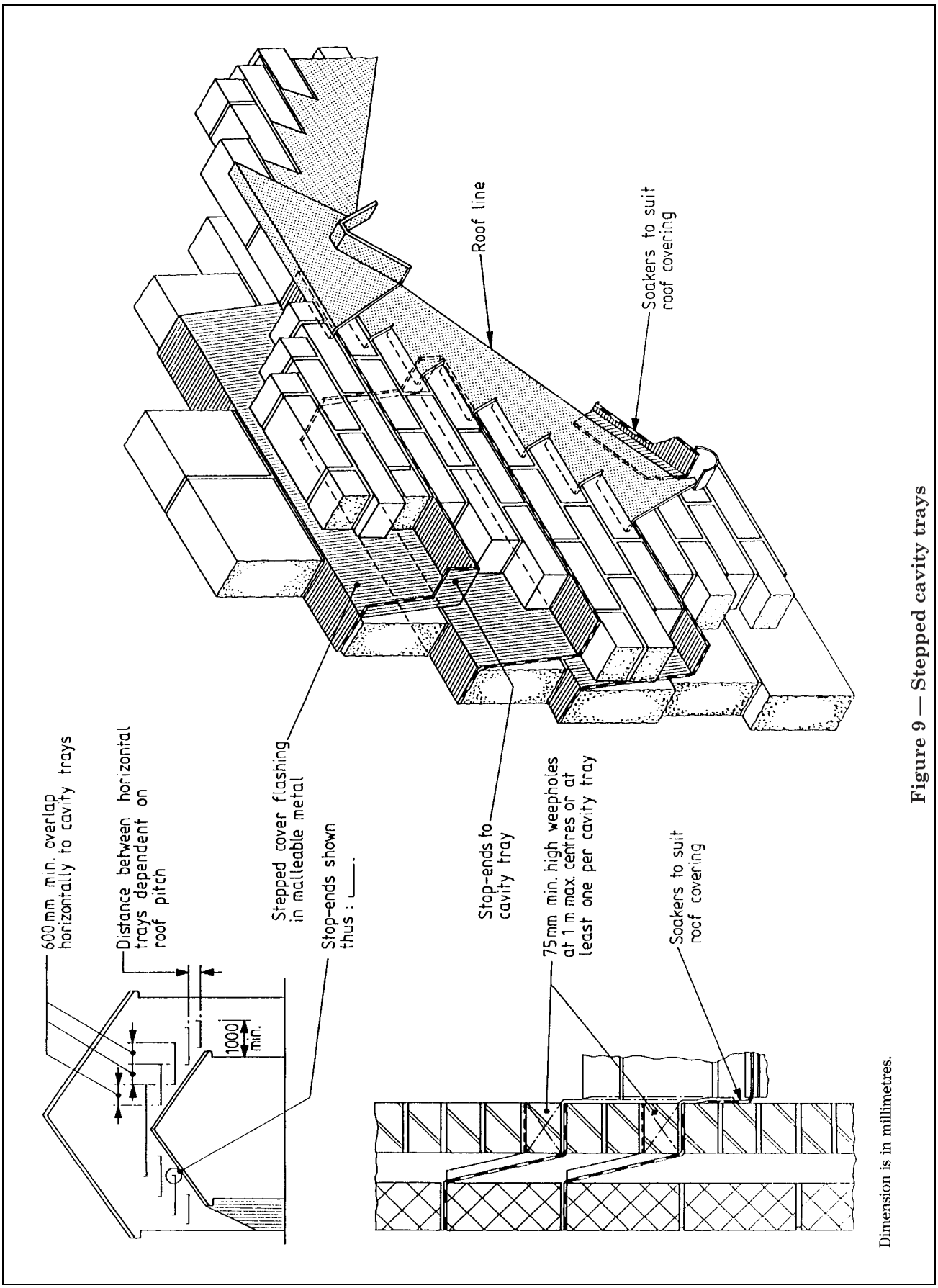


Figure 9 — Stepped cavity trays

Where a cavity wall forms a parapet extending more than 150 mm above a roof it is likely to be exposed to rainwater on both sides: a cavity tray which will deflect water away from the inner leaf and allow it to drain out without by-passing the roof covering should then be incorporated (see Figure 10).

5.6 Selection of DPC material

Not all materials are equally suitable for use in all conditions; the designer should use discretion in selecting a DPC and should have regard to the anticipated life of the building and the structural and detail requirements of each application. For example, properly jointed and supported flexible sheet materials can provide a barrier over large areas and across cavities: they should always be used where a stepped DPC is required as they can accommodate minor movement at changes of direction.

Sheet lead is particularly ductile and can be formed into complex shapes; it may corrode in contact with mortar, however, and should be protected by the application of bituminous paint.

Sheet copper can support high compressive stress but may be attacked by soluble salts from masonry materials and some soils: it should be protected in the same way as sheet lead.

Polyethylene sheet is not suitable for use where subjected to low compressive stress (e.g. under copings). It should not be used to prevent the downwards movement of moisture, unless continuous or effectively jointed.

Semi-rigid mastic asphalt can provide an impervious barrier to water under pressure: it should be laid onto a fully supporting rigid substrate.

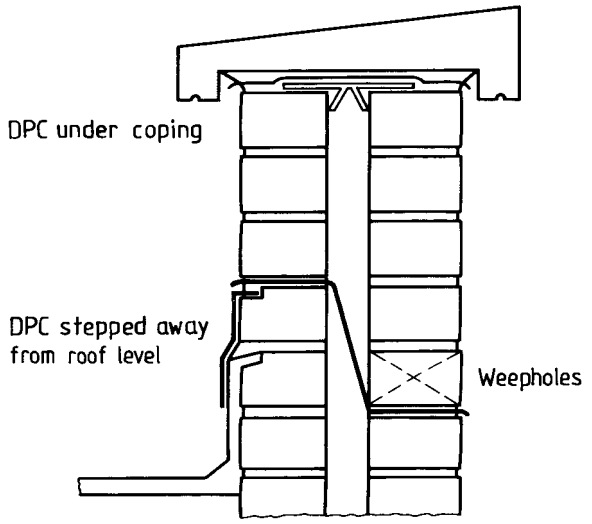


Figure 10 — DPC in a cavity parapet wall

Damp-proof constructions formed with dense bricks or slates are particularly suitable for use in free-standing walls, in massive constructions and in chimney stacks, but should not be used to resist water under pressure.

There are four principal considerations which should be taken into account when selecting DPCs.

a) *Durability:* the materials selected should be strong enough to resist accidental damage during construction and their durability should match the planned life of the building into which they are incorporated.

b) *Resistance to stress:* see Table 2.

1) Creep deformation: a material which will withstand the load to be imposed upon it should be selected.

NOTE 1 Creep deformation is dependent upon the compressive stress induced by the weight of the structure bearing on the DPC. This stress has been graded into four classes:

i) high, stresses above 2.5 N/mm^2, which are generated in walls higher than l0 storeys;

ii) medium, stresses in the range of 0.5 N/mm^2 to 2.5 N/mm^2, which are generated in walls between 10 and four storeys high;

iii) low, stresses in the range 0.1 N/mm^2 to 0.5 N/mm^2, which are generated in walls up to four storeys;

iv) minimal, stresses less than 0.1 N/mm^2, e.g. in copings, parapet walls.

2) Shear stress: a DPC material which has a good bond strength and resistance to deformation should be chosen to withstand shear stress (a tendency to sliding) in retaining walls.

3) Flexural stress: a high bond strength material should be used to prevent failure of the wall along the plane of the DPC (see also **18.4.1** d) of BS 5628-3:1985).

NOTE 2 The force of the wind imposes flexural stress, i.e. a tendency to overturn, on free standing walls and parapets.

c) *Pliability:* a material which will be easy to shape on site should be used if there are many changes of direction or level in the DPC.

d) *Compatibility:* under certain circumstances flexible sheet metal DPC material should be protected against corrosion. Lead will corrode if it is in contact with mortar and should be fully coated on both sides with bitumen paint. Copper is vulnerable to corrosion in the presence of soluble salts which may be found in many masonry materials and in clinker ash and some soils: copper DPCs should therefore be coated with bitumen paint in the same way as lead.

Table 2 — Structural considerations affecting the selection of DPCs

Material	Resistance to stress[a] (see 5.6)					
	Compressive stress				Shear stress	Flexural stress
	High (> 2.5 N/mm^2)	Medium (0.5 N/mm^2 to 2.5 N/mm^2)	Minimal (< 0.1 N/mm^2)			
Flexible						
Lead complying with BS 1178	×	✓	✓	✓	×	✓
Copper complying with C 104 or C 106 of BS 2870 0 grade	✓	✓	✓	✓	×	✓
Bitumen with:						
Hessian base (class A of BS 6398)	×	×	✓	✓	×	×
Fibre base (class B of BS 6398)	×	×	✓	✓	×	×
Asbestos base (class C of BS 6398)	×	×	✓	✓	×	×
Hessian base and lead (class D of BS 6398)	×	×	✓	✓	×	×
Fibre base and lead (class E of BS 6398)	×	×	✓	✓	×	×
Asbestos base and lead (class F of BS 6398)	×	×	✓	✓	×	×
High bond strength asbestos base	×	×	✓	✓	✓	✓
Low density polyethylene complying with BS 6515	✓	✓	✓	×	×	×
Bitumen polymer and pitch polymer	✓	✓	✓	✓	✓	✓
Semi-rigid						
Mastic asphalt complying with BS 6925 or BS 6577	×	✓[b]	✓	✓	✓	✓
Rigid						
DPC brick complying with BS 3921	✓	✓	✓	✓	✓	✓
Slate complying with BS 743	✓	✓	✓	✓	✓	✓

[a] ✓ acceptable; × unacceptable.
[b] Up to 0.65 N/mm^2.

6 Sitework

6.1 General

Having selected the DPC materials it is important that clear and unambiguous instructions should be drawn up for use by site operatives (see BS 8000-3).

6.2 Receiving, checking and storing materials

Check all materials against delivery tickets and against the specification; examine marks, labels and condition of the materials. If not satisfied reject the materials and remove them from site.

Store DPC materials in a dry area, under cover, and protect against damage. In addition, with flexible materials take the following measures:

a) Stand rolls on their ends as a stable stack not more than three packs or 1 m high.

b) Keep bitumen and other thermoplastic materials away from any direct heat source.

c) Store sufficient rolls for the next day's use in a warm place overnight as some materials may become stiff and brittle in cold weather.

Adhesives can be hazardous to store if they give off solvent vapours. Follow the manufacturer's instructions concerning any storage requirements, such as the avoidance of high or low temperatures, and for any special ventilation requirements.

6.3 Functional Requirements

The DPC should provide an impervious barrier to the passage of rain and ground water, and should prevent water penetrating to the inside of the building. It is essential, therefore, that DPC material should be handled and installed with care to provide a completely waterproof system.

NOTE 1 Passage of water may be horizontal, upwards or downwards.

Where the DPC is intended to resist the downward movement of water all joints and laps should be completed in accordance with Table 3.

NOTE 2 If the joints are not sealed correctly then water may by-pass the DPC.

Particular attention should be paid to parapet walls and junctions at columns and concrete frames (see Figure 11).

NOTE 3 Where the DPC is intended to resist the upward movement of water by capillary action, joints may be simply lapped without sealing them.

To allow water to drain out of the cavity, weepholes should be formed in cavity walling by leaving out the mortar from the cross joints in the outer leaf immediately above the cavity tray. The maximum distance between weepholes should be 1 m.

It is essential that a DPC should extend the full width of the wall, including any surface finishes (see Figure 12). It is vitally important that the barrier should be continuous.

Table 3 — Joints in DPCs

DPC material	Jointing method	
Bitumen	Lap 100 mm minimum and seal with cold applied roofing felt adhesive	
Pitch and bitumen polymer	Lap 100 mm minimum and seal with adhesive according to manufacturer's instructions	
Lead and copper	Solid wall construction	Cavity wall construction
	Form welts	Form single-welted upstands in the perpends at 1.5 m maximum centres
Polyethylene	Lap 100 mm minimum and seal according to manufacturer's instructions	

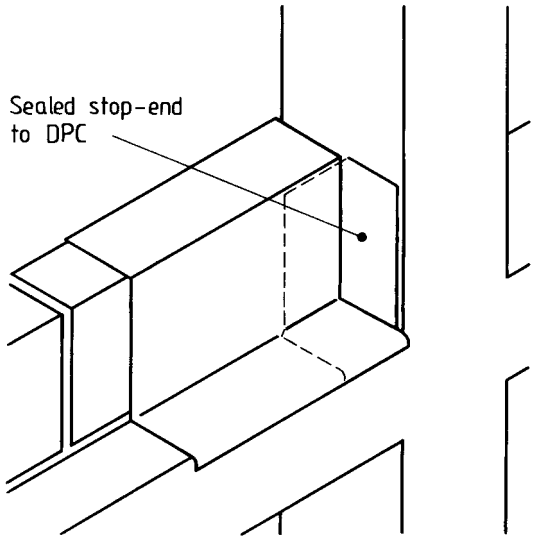


Figure 11 — DPCs at junction in concrete frame

Pay particular attention to the continuity at ground level where the DPC links with the damp-proof membrane or tanking. Make sure that there is a minimum of 50 mm overlap (see Figure 13).

When laying a DPC beneath jointed or pervious copings and cappings, lay the DPC and the coping or capping units on a bed of fresh mortar. Beneath copings allow the edge of the DPC to project 5 mm beyond the wall face; beneath cappings, finish the DPC flush with the brickwork.

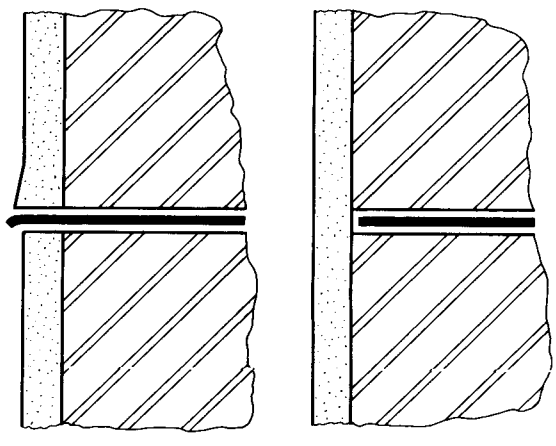
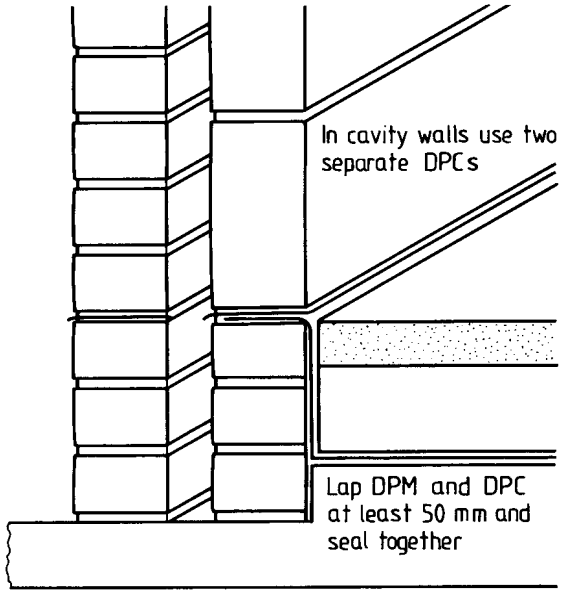


Figure 12 — Continuity of DPC



NOTE. DPM stands for damp-proof membrane.

Figure 13 — Detail of DPC overlap

6.4 Installing a DPC of flexible sheet materials

Certain metals may require protection against corrosion (see **5.6**). If protection is specified, apply it and allow it to dry before laying the DPC.

To install a flexible DPC, first lay a full even bed of the same type of mortar as in the course below and flush it up level. Lay the DPC on the mortar bed in a continuous length for the full width of the leaf (see Figure 14). Make sure that there is at least a 100 mm overlap at any joint or angle and that the overlap is sealed or welted as appropriate (see Table 3).

As soon as possible after laying the DPC, lay at least one further course of masonry, including a full bed of mortar: this will help develop good adhesion between masonry units, mortar and DPC.

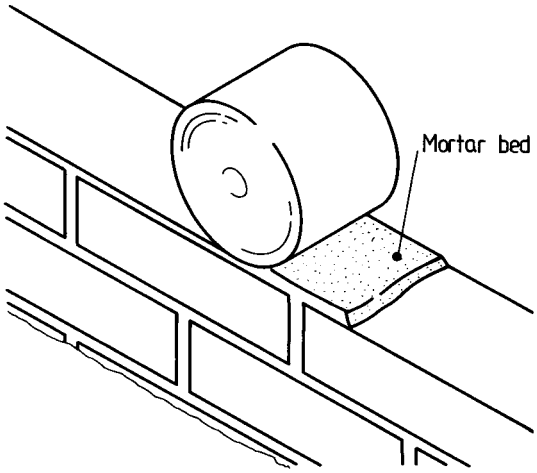


Figure 14 — Installation of a flexible DPC

6.5 Installing a DPC of mastic asphalt

Prepare a mix of the specified asphalt, type T1418 complying with BS 6577, or type T1097 complying with BS 6925. Adjust the coarse aggregate content to 35 % by mass. Lay a single 12 mm thick coat of asphalt on each leaf of the wall.

While the mastic is still warm, to provide a key for the next course of brickwork either score the surface of the mastic or beat further grit into the surface leaving the grit standing slightly proud.

6.6 Constructing a DPC of brickwork or slates

DPCs of brickwork should be formed with at least two courses of DPC category bricks laid in designation (i) mortar (1 : 0 to ¼ : 3 cement : lime : sand; see BS 5628-1). Joints between bricks should be staggered in alternate courses; all bed joints and cross joints should be filled solid with mortar.

A slate DPC should be formed of two courses of slates, each slate as long as possible to minimize joints, bedded in designation (i) mortar (1 : 0 to ¼ : 3 cement : lime : sand), with joints between slates staggered in alternate courses. The width of the slates should match the overall thickness of the wall.

6.7 Installing DPCs in cavity walls

DPCs in cavity walls protect the building against water moving down the inside face of the outer leaf : such DPCs should be designed in accordance with clause **5**. They should also be installed correctly to be effective.

A cavity tray should, wherever possible, be formed without joints. If joints cannot be avoided, provide rigid support at the joint, forming a lap of at least 100 mm, and seal it to avoid the risk of water by-passing the DPC (see Table 3).

A cavity tray should be stepped up 150 mm from the outer to the inner leaf and be supported to prevent it from sagging.

A discontinuous cavity tray should extend at least 25 mm beyond any vertical DPC and stop-ends should be provided (see Figure 15).

When fitted above a lintel the cavity tray should extend at least to the ends of the lintel. When the lintel runs continuously across narrow piers, the cavity tray should be installed as a single piece across piers which are 600 mm or less in width (see Figure 16).

When installing a flexible DPC at the jamb of an opening make sure that it laps under the DPC at the lintel and over the DPC at the sill. Ensure the DPC is in close contact with the frame and that it is held in place to prevent it from sagging. The DPC should be bedded and pointed in mortar, and it should project at least 25 mm into the cavity.

Because changes of direction of a cavity tray are more complicated than joints and would involve complex bending and folding if fabricated on site, it is recommended that prefabricated corner units are used. However, it is important that these prefabricated units should be sealed to the cavity tray. Figure 17 illustrates the principles involved. The most important things to remember are that all laps should be sealed and that the DPC should not be bridged by mortar droppings.

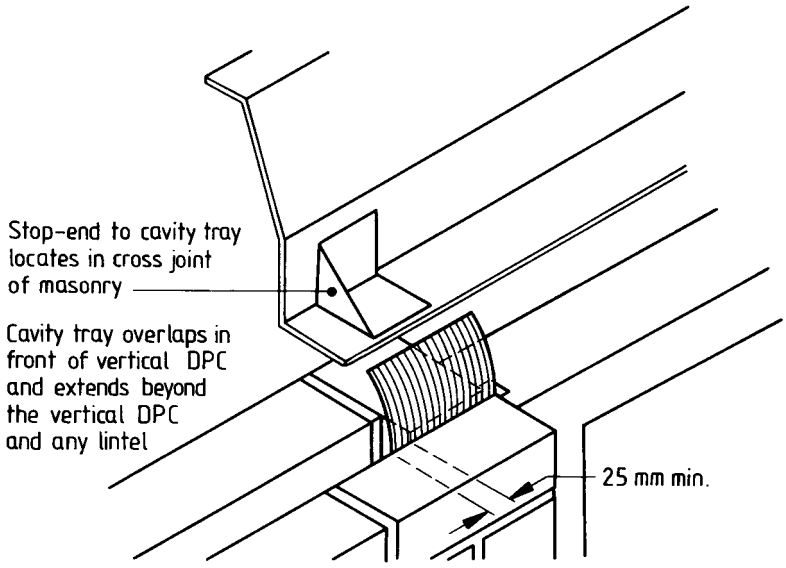


Figure 15 — Cavity tray with stop-ends

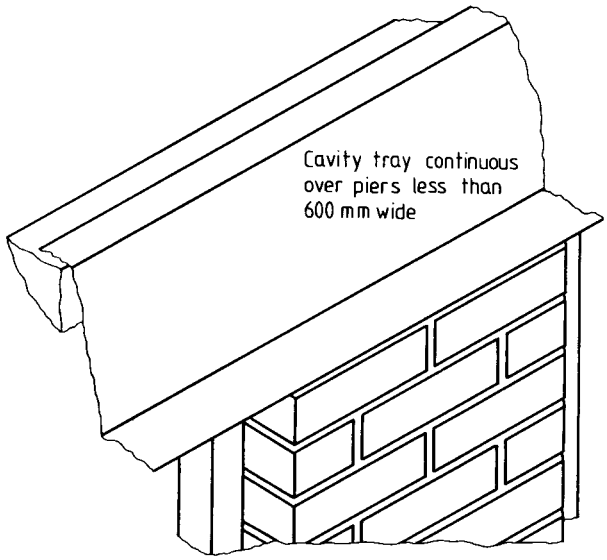


Figure 16 — Cavity tray across piers

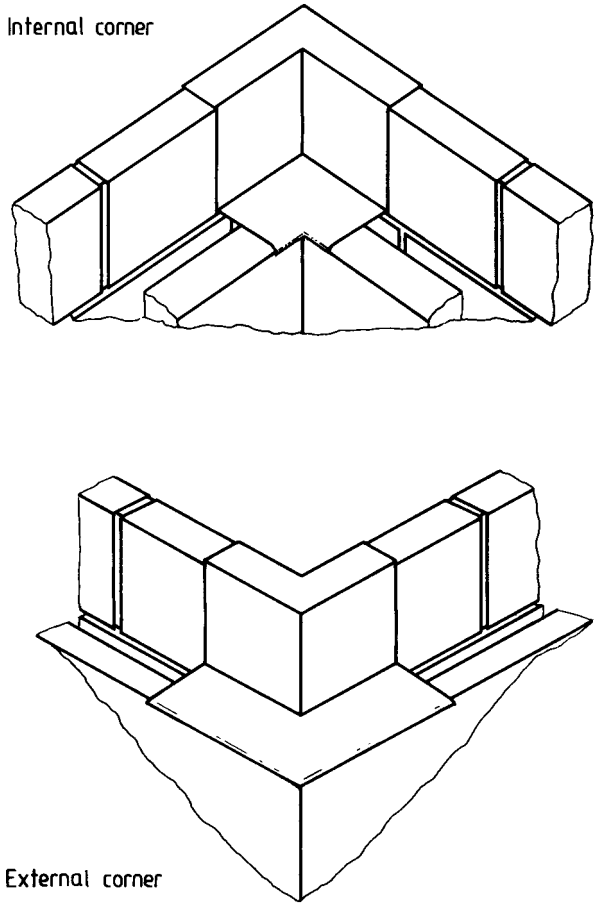


Figure 17 — Formation of internal and external corners

blank

Publications referred to

BS 743, *Specification for materials for damp-proof courses.*
BS 1178, *Specification for milled lead sheet for building purposes.*
BS 2870, *Specification for rolled copper and copper alloys: sheet, strip and foil.*
BS 3921, *Specification for clay bricks.*
BS 5250, *Code of practice for control of condensation in buildings.*
BS 5628, *Code of practice for use of masonry.*
BS 5628-1, *Structural use of unreinforced masonry.*
BS 5628-3, *Materials and components, design and workmanship.*
BS 5642, *Sills and copings.*
BS 5642-1, *Specification for window sills of precast concrete, cast stone, clayware, slate and natural stone.*
BS 6100, *Glossary of building and civil engineering terms.*
BS 6100-5, *Masonry.*
BS 6398, *Specification for bitumen damp-proof courses for masonry.*
BS 6477, *Specification for water repellents for masonry surfaces.*
BS 6515, *Specification for polyethylene damp-proof courses for masonry.*
BS 6576, *Code of practice for installation of chemical damp-proof courses.*
BS 6577, *Specification for mastic asphalt for building (natural rock asphalt aggregate).*
BS 6925, *Specification for mastic asphalt for building and civil engineering (limestone aggregate).*
BS 8000, *Workmanship on building sites.*
BS 8000-3, *Code of practice for masonry.*
BS 8102, *Code of practice for protection of structures against water from the ground.*
CP 102, *Code of practice for protection of buildings against water from the ground*[1)].
DD 86, *Damp-proof courses*[1)].
DD 86-1, *Methods of test for flexural bond strength and short term shear strength.*
DD 86-2, *Method of test for creep deformation.*
DD 86-3, *Guide to characteristic strengths of damp-proof course materials used in masonry.*

[1)] Referred to in the foreword only.

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