Design Detail for Durability of Brickwork

1. Durability of Bricks

Resistance to freeze/thaw action is the major characteristic of a brick's durability and it varies across the range of clay bricks produced for construction work.

BS EN 771-1, "*Specification for masonry units - Part 1: Clay masonry units*" defines three categories of freeze/thaw resistance:

F0 - Passive exposure	For internal construction or masonry protected by impervious cladding
F1 - Moderate exposure	For masonry provided with features to prevent saturation, e.g. roof overhangs or copings, projecting throated sills, damp proof courses.
F2 - Severe exposure	For masonry not provided with features to prevent saturation as noted for F2

The property is not an absolute one - the term is freeze/thaw resistance, not proof.

It is important to note that clay bricks covered by BS EN 771-1 are intended for **the construction of masonry structures**, e.g. walls, foundations and chimney stacks, normally jointed with mortar. The Standard does not cover bricks to be used for paving, more correctly termed "pavers", which are covered by a separate Standard, BS EN 1344.

Northcot clay facing bricks are frost resistant, conforming to F2 freeze/thaw resistance as described in BS EN 771-1.

F2 durability designation bricks have superior resistance to frost damage and can be used for masonry that, parts of which, are exposed to substantial wetting by rain or ground water and freezing temperature. However, such **masonry should be designed to minimize the extent of severe wetting and long term build up of a saturated condition**. This document is intended to provide advice on design. British Standard Publication PD 6697, "*Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996 - 2*" includes the specification of materials and design details to promote durability.

PD 6697 contains the majority of the recommendations contained in BS 5628-3, "*Code of practice for the use of masonry - Materials and components, design and workmanship*", which was withdrawn in March 2010 following the supersession of the BS 5628 suite of standards for masonry structural design by BS EN 1996, "Eurocode6: Design of masonry structures".

The following notes on the durability aspects of various brickwork constructions are based on the recommendations of the British Standards currently in effect:

- Copings, cappings and sills
- Chimney terminals
- Bricks below DPC and at ground level
- Freestanding walls
- Retaining walls

BDA Design Note 7, "*Brickwork Durability*" provides useful and comprehensive guidance. It is available as a free download on the Brick Development Association website www.brick.org.uk

2. Copings Cappings and Sills

The distinction between a coping and a capping is significant:

A coping is a construction, or component, that protects the top of a wall or parapet and sheds rainwater clear of the wall surface below. To be effective it should be weathered, throated and overhang the wall surface.

A capping is a construction, or component, that protects the top of a wall or parapet, but does not shed rainwater clear of the wall surface below.

There are two basic forms of **sills** to openings:

i) Projecting - weathered, throated and overhanging the wall surface below

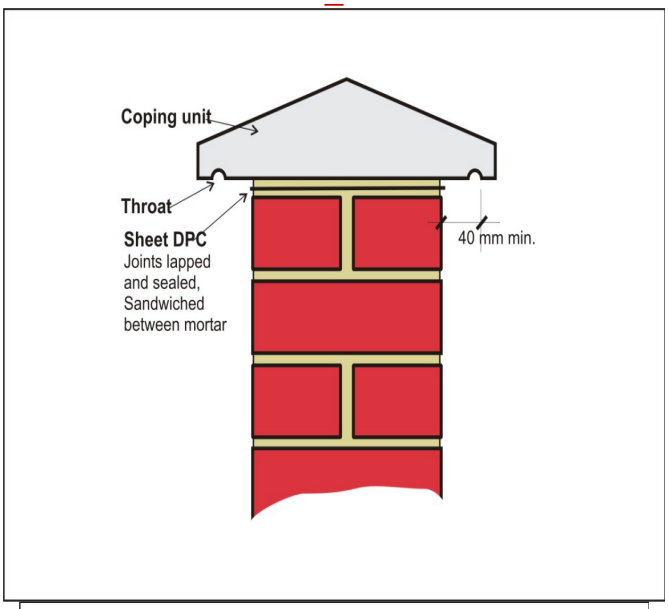
and ii) Flush with the wall surface below

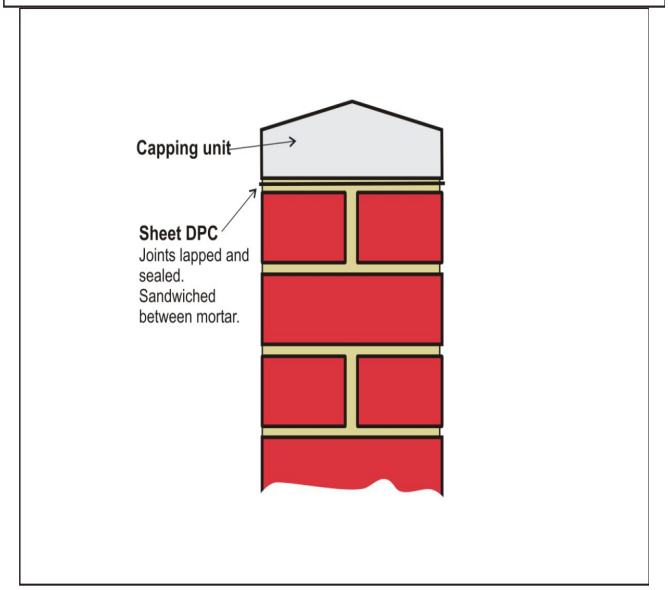
Any mortar jointed coping, capping or sill will permit water to penetrate its joints and percolate down into the brickwork below. Therefore a flexible sheet DPC should be installed in the bed joint below the coping, capping or sill units. The DPC should have good bonding performance (e.g. a bitumen polymer sheet material) and it should be sandwiched between mortar. The DPC should be laid in one piece where practicable. Any joints should be lapped and sealed. Creasing tiles, slates or DPC bricks are not an acceptable alternative to a flexible DPC below copings cappings or sills

A brick-on-edge capping on two courses of creasing tiles is a traditional detail, but the assembly does not stop the downward percolation of water and a flexible sheet DPC should be incorporated. Good practice is to use an engineering type clay brick in areas of high or permanent saturation.

Coping, capping and sills formed of impervious material, e.g. metal or plastic, in one piece or with waterproof joints do not require a DPC.

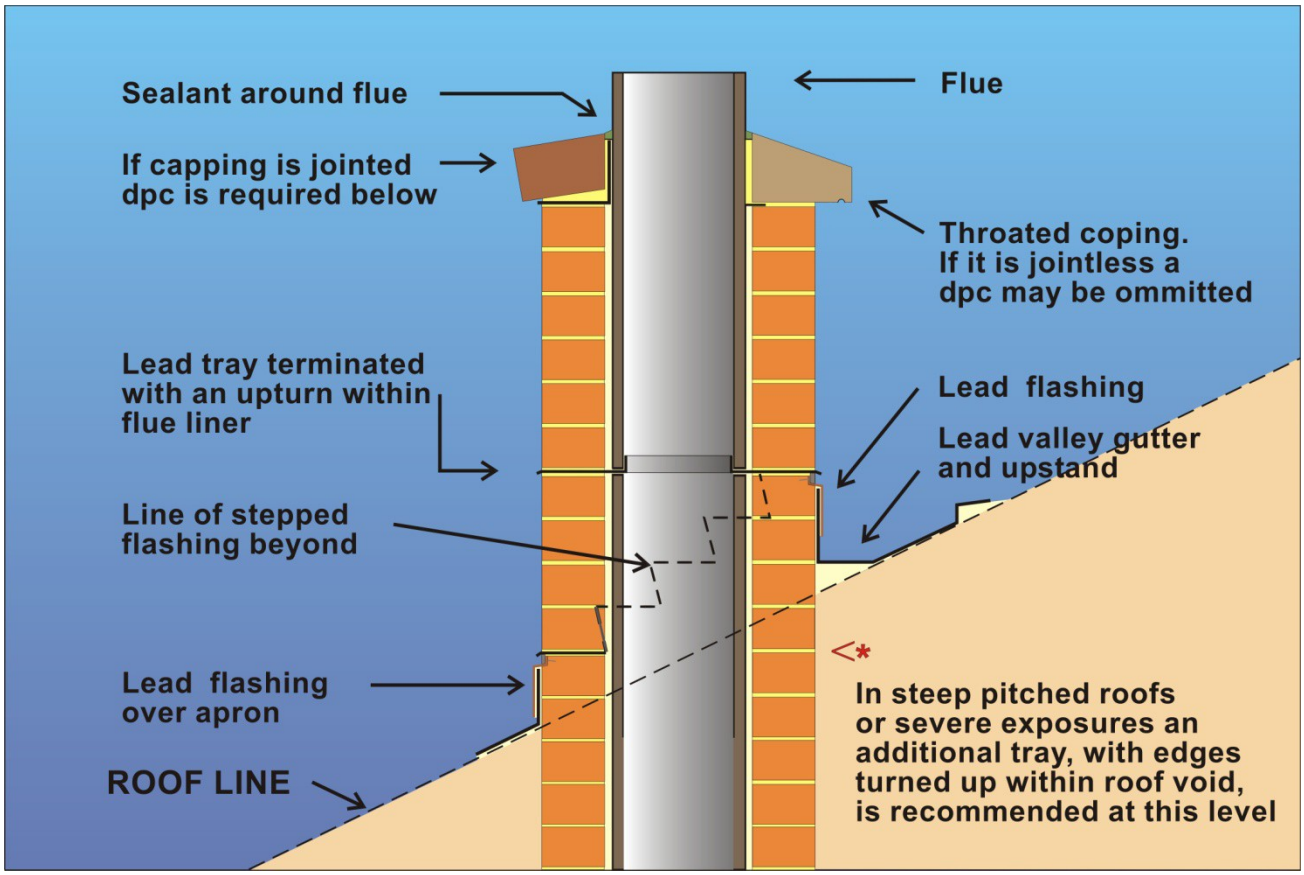
Typical coping and capping


Coping unit
Throat
Sheet DPC
Joints lapped
and sealed,
Sandwiched
between mortar
40 mm min.


Capping unit
Sheet DPC
Joints lapped and
sealed.
Sandwiched
between mortar.

3. Chimney Terminals

Chimney terminals, because of their necessarily unsheltered positions, are subject to severe exposure to wetting by rain and to freezing temperatures. The following section drawing of a typical chimney for a domestic building, or one of similar scale, illustrates recommendations for the design features of such a structure.



A brick-on-edge capping (or any mortar jointed capping or coping) will permit water to penetrate its joints and percolate down into the brickwork below. Therefore a flexible sheet DPC should be installed in the bed joint below the capping or coping units. The DPC should have good bonding performance (e.g. a bitumen polymer sheet material) and be sandwiched between mortar. Any joints in the DPC should be lapped and sealed.

To minimize water penetrating the face of the wall, mortar joints should not be finished with deeply raked joints. Profiles finished with a tooled finish are preferable. If a recessed profile is required the recess should be restricted (say 3mm max) and the mortar surface firmed with a jointing iron.

Mortar flaunching as a capping surface is not uncommon, but it is very prone to cracking that will allow water to penetrate into the top of the brickwork. The flaunching then restricts drying out and the high moisture content in the brickwork makes it vulnerable to frost damage.

If a terminal of a decorative design is required, perhaps following historical examples, consideration should be given to any exposed ledges formed by steps in the brickwork, e.g. a lead capping dressed down over the top edge of the brickwork, or a one piece reconstructed stone, or precast concrete terminal.

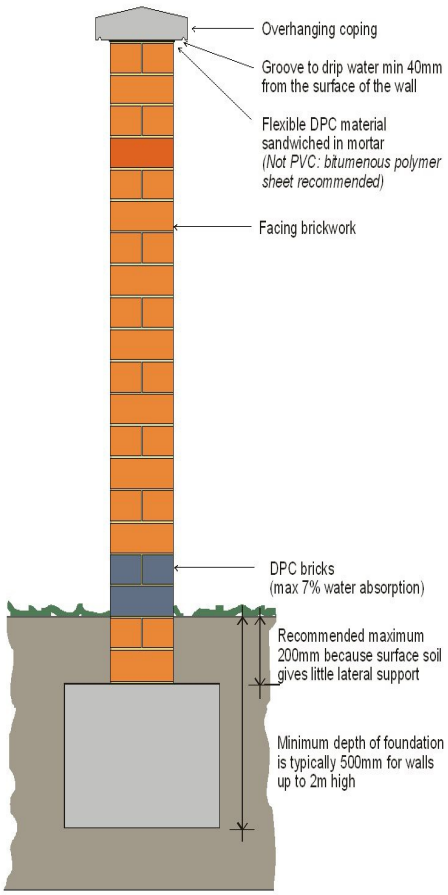
4. Bricks Below DPC and at Ground Level

Bricks between DPC and ground level at the base of an external wall are not particularly at risk from excessive wetting or frost damage in normal circumstances. The position is often relatively sheltered from both rain and frost. If the ground is well drained and possibly planted there is low risk of excessive wetness or frost damage. F2 and F1 freeze/thaw resistant bricks are considered satisfactory in these conditions.

Surface water should not be permitted to pond at the base of a wall. If the ground at the base of a wall does attract and hold water against brickwork some provision for drainage should be made.

Paving or other hard surfacing abutting the base of a wall should be laid to falls that incline away from it. If that is not possible a drainage channel or a drained gravel filled margin should be installed at the base of the wall.

5. Freestanding Walls



A Typical Freestanding Wall

Freestanding walls are vulnerable to extra wetting because both sides are exposed to the weather. F2 freeze/thaw resistant bricks are therefore very suitable for such walls. At the top of the wall a coping provides better protection than cappings and although a capping can be used with F2 bricks a coping gives better protection and reduces any risk of staining. Both copings and cappings require DPC beneath them unless they are impervious and joints are waterproof.

To minimize water penetrating the face of the wall, mortar joints should not be finished with deeply raked joints. Profiles finished with a tooled finish are preferable. If a recessed profile is required the recess should be restricted (say 3mm max) and the mortar surface firmed with a jointing iron.

Flexible sheet DPCs are not recommended for use at the base of a freestanding wall because their bond performance with mortar is inferior to that of masonry units. They would therefore constitute a line of relative weakness at the base of the wall that would make it vulnerable to over toppling. For this reason it is acceptable to omit a DPC in a freestanding wall.

Alternatively, two courses of DPC bricks can be used as a barrier to moisture rising from the ground.
There are two categories: DPC brick Type 1 and Type 2, with maximum water absorptions of 4.5%, and 7% respectively. Either type may be used in landscape structures. They are particularly suitable in a freestanding walls and retaining walls.

DPC bricks should be laid lap jointed with Designation (i) mortar (strength class M12) i.e.1:0-$^{1}/_{4}$:3 by volume of cement, lime and sand.

IMPORTANT: Freestanding walls must be designed with regard to location, exposure to wind, required height and thickness. Inadequate design could result in collapse with fatal consequences.

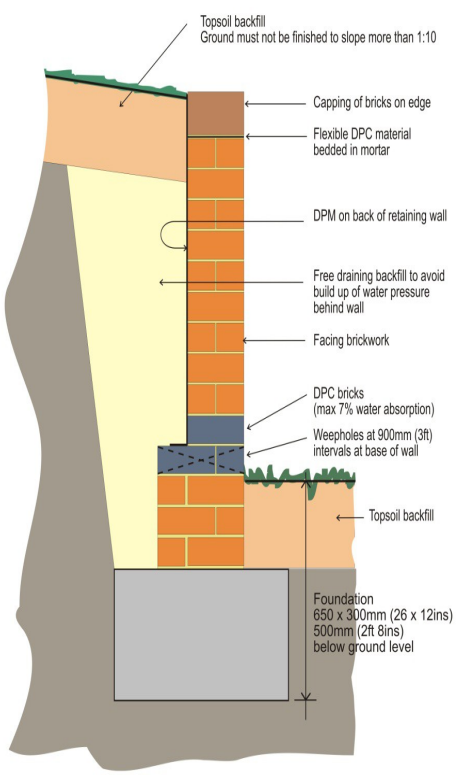
* See note ***"Structural Design"*** at the end of the next section 'Retaining Walls'

6. Retaining Walls

The following section drawing of a typical retaining wall illustrates recommendations for

the design features of such a structure.

Figure 4.25: Vertical section through retaining wall



A retaining wall is susceptible to wetting from:

i) rain falling on the capping and percolating downwards into the wall
ii) wind driven rain on the wall face
iii) water from the retained ground entering the back of the wall

i) A brick-on-edge capping (or any mortar jointed capping or coping) will allow water to penetrate its joints and percolate down into the brickwork below. Therefore a flexible sheet DPC should be installed below the capping or coping. The DPC should have good bonding performance (e.g. a bitumen polymer sheet material) and be sandwiched between mortar.

ii) To minimize water penetrating the face of the wall, mortar joints should not be finished with deeply raked joints. Profiles finished with a tooled finish are preferable. If a recessed profile is required the recess should be restricted (say 3mm max) and the mortar surface firmed with a jointing iron.

iii) On the back (retaining surface) of the wall a DPM (damp proof membrane) should be applied to prevent ground water from the retained soil entering and penetrating the brickwork. The DPM will also prevent soluble material from the retained soil moving through the brickwork and perhaps causing staining on the face of the wall.

The backfill material should be free draining to prevent the build up of hydrostatic pressure on the retaining surface of the wall. A land drain could be laid in the base of the free draining backfill, or weepholes could be incorporated through the base of the wall.

As with freestanding walls, for structural reasons a sheet DPC material is not recommended as a suitable DPC at the base of a retaining wall. Two courses of DPC bricks (max 7% Water Absorption) can be used as shown in the accompanying drawing of a typical retaining wall. See *5. Freestanding Walls* about mortar for DPC bricks. However, DPC bricks might not be acceptable for aesthetic reasons and a DPC at the base of a retailing wall could be omitted.

NOTE: DPC bricks are only effective as a barrier to rising damp at the base of a wall.

It is sometimes assumed that DPC bricks (or Engineering bricks) can be used to build waterproof brickwork. However, this is an error because, even with a strong dense mortar for the joints, the brickwork will not be waterproof against water under pressure. A skin of engineering bricks is not the equivalent of a DPM on the rear face of a retaining wall.

Structural Design

Both freestanding walls, and retaining walls should be designed with due regard to the lateral loads and the height of the wall. A Structural Engineer should be consulted on this matter.

The Building Research Establishment publishes three **Good Building Guides** for the safe design of freestanding walls and retaining walls for application in various parts of the British Isles:

GBG 14: Building Simple Plain Brick or Blockwork Freestanding Walls
GBG 19: Building Reinforced, Diaphragm and Wide plan Freestanding Walls
GBG 27: Building Brick and Blockwork Retaining Walls

Contact details: Building Research Establishment
Garston, Watford , Hertfordshire WD2 7 JR
Tel: 01923 664000 For publications: www.brebookshop.com