British Cement Association

National House-Building Council

The Building Regulations 1991

APPROVED DOCUMENT

Basements for dwellings

Acknowledgements

This publication was produced by the British Cement Association under a Department of the Environment research contract, with the National House-Building Council as the principal sponsor.

The BCA is grateful to the above sponsors, to the Steering Group which directed the preparation of this publication and for the contribution from members of the Basement Development Group as well as all those who provided comments on the draft at the public comment stage. Particular thanks go to those involved with the research contractor, *Tecnicom*, in the preparation and production of this publication.

Steering Group:
British Cement Association
Department of the Environment
Institute of Building Control
National House-Building Council

Basement Development Group:
Association of Building Engineers
Autoclaved Aerated Concrete Products Association
British Cement Association
British Structural Waterproofing Association
Bovis Homes
B Keyworth, Architects
Building Research Establishment
House Builders Federation
Institute of Building Control
Institute of Clerks of Works
Mortar Producers Association
National House-Building Council
Ready-mixed Concrete Bureau
Tecnicom
Zurich Municipal

Principal Sponsor:
National House-Building Council
Buildmark House, Chiltern Avenue
Amersham, Bucks HP6 5AP

48.062
First published 1997
ISBN 0 7210 1508 5
Price group G

Published by
British Cement Association
Century House, Telford Avenue
Crowthorne, Berks RG45 6YS
Telephone (01344) 762676
Fax (01344) 761214

APPROVED DOCUMENT – BASEMENTS FOR DWELLINGS

USE OF GUIDANCE

THE APPROVED DOCUMENTS

This document has been prepared by the Basement Development Group on behalf of the British Cement Association (BCA) and the National House-Building Council (NHBC). It is approved by the Secretary of State under Section 6 of the Building Act 1984 as practical guidance on meeting the requirements of relevant paragraphs in Schedule 1 to the Building Regulations 1991 (as amended 1994) as they apply to the incorporation of basements to dwellings.

In its specific application this publication supplements the basic level of guidance provided by the Secretary of State in each part of the Regulations. Like all Approved Documents, this document places no obligation on the user to adopt any of the given provisions if compliance with the requirements of the Building Regulations can be demonstrated in some other way.

Other requirements

The guidance contained in an Approved Document relates only to the particular requirements of the Regulations which that Document addresses. The building work will also have to comply with the requirements of any other relevant paragraphs of Schedule 1 to the Regulations. There are Approved Documents which give guidance on the requirements in Schedule 1 and on regulation 7.

Limitations on requirements

In accordance with regulation 8, the requirements in Parts A to K and N of Schedule 1 to the Building Regulations do not require anything to be done except for the purpose of securing the reasonable health and safety of persons in or about the building.

MATERIALS AND WORKMANSHIP

Any building work which is subject to requirements imposed by schedule 1 of the Building Regulations should, in accordance with regulation 7, be carried out with proper materials and in a workmanlike manner.

You may show that you have complied with regulation 7 in a number of ways, for example, by appropriate use of a product bearing a CE marking in accordance with the Construction Products Directive (89/106/EEC) as amended by Council Directive 93/68/EEC of 22 July 1993, published in the official Journal of the European Communities No. L221/1 of 30/8/93, or by following an appropriate technical specification (as defined in that Directive), a British Standard, a Technical Approval or an alternative National Specification of any member state of the European Union which, in use, provides an equivalent level of protection and performance with respect to the relevant requirements of Schedule 1. You will find further guidance in the Approved Documents supporting regulation 7 on materials and workmanship.

Technical specifications

Building Regulations are made for specific purposes: health and safety, energy conservation and the welfare and convenience of disabled people. Standards and technical approvals are relevant guidance to the extent that they relate to these considerations. However, they may also address other aspects of performance such as serviceability or aspects which, although they relate to health and safety, are not covered by the Regulations.

1 INTRODUCTION

1.1 This Approved Document provides guidance on the design and construction of basements for dwellings. It takes into account the effect on dwellings of including a basement and describes the means of meeting the relevant performance requirements of the Building Regulations. Each guidance clause in this Document is preceded by the Requirement (eg A1) to which the guidance relates. This document also covers good practice recommended by NHBC and BCA. This is identified by *GP* in the left hand margin and the accompanying boxed italic text.

1.2 Throughout this Document the diagrams are illustrative only, and do not show all the detail of construction.

1.3 The guidance on structure in Section 3 applies to dwellings with basement walls retaining not more than 2.7 m height of ground.

1.4 This Document deals with those parts of the requirements from Schedule 1 to the Building Regulations 1991 (as amended 1994) which are of direct relevance to the inclusion of basements but, unless otherwise noted in Sections 2 to 12, the provisions of all other Approved Documents should also be met.

1.5 The provisions in Sections 2 to 12 are based on the requirements and Approved Documents in force on the date of this publication. Account should be taken of any subsequent amendments or alterations to the referenced documents.

1.6 Guidance on meeting Requirement G, Hygiene, of Schedule 1 of the regulations is not given in this Document, but is contained in Approved Document G.

1.7 This document does not include guidance on meeting Requirement M, Access and facilities for disabled people, of Schedule 1 of the regulations, since the limits of application of this requirement excludes dwellings.

1.8 Vehicle access to garages is not covered by the Building Regulations but is dealt with as good practice guidance in Section 12.

2 SITE PREPARATION AND RESISTANCE TO MOISTURE

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part C of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document C should also be followed or the requirements should be met in some other way.

REQUIREMENT	LIMITS ON APPLICATION
C1 PREPARATION OF SITE The ground to be covered by the building shall be reasonably free from vegetable matter.	
C2 DANGEROUS AND OFFENSIVE SUBSTANCES Precautions shall be taken to avoid danger to health and safety caused by substances found on or in the ground to be covered by the building.	
C3 SUBSOIL DRAINAGE Subsoil drainage shall be provided if it is needed to avoid – (a) the passage of ground moisture to the interior of the building; (b) damage to the fabric of the building.	
C4 RESISTANCE TO WEATHER AND GROUND MOISTURE The walls, floors and roof of the building shall resist the passage of moisture to the inside of the building.	

2 SITE PREPARATION AND RESISTANCE TO MOISTURE

2.1 SITE INVESTIGATION

2.1.1 ***GP***

Before starting any design or construction work, a site investigation, including a desk study, should be made to establish the ground conditions (including the type of subsoil), the level of the water table (including the provision for natural drainage), the location of any existing drains or other services, the presence of contaminants and whether there is a risk from radon. It should be noted that a subsoil drain which shows no presence of water may subsequently become active at certain times of the year.

2.2 CONTAMINANTS

2.2.1 **C2**

If the site investigation indicates the presence in the ground of solid or liquid contaminants, natural gases (eg radon) or landfill gases, then appropriate measures should be taken to limit their effect on the basement and on the remainder of the dwelling.

Reg 7

In addition to complying with the provisions of Approved Document C: Section 2, the possible effects of contaminants on the materials used in basement construction should be considered and appropriate specifications selected.

2.2.2 **C2**

Where the presence of landfill gas is suspected, expert advice should be sought and a complete investigation carried out into the nature of any hazardous gas, its source and the potential of the landfill site for future gas generation. Gases similar to landfill gas can also arise naturally, and should be treated in the same way as those arising from landfills. Where the presence of landfill gas is confirmed, the measures given in Approved Document C should be followed. Supplementary information is given in the BRE publication, BR 212: *Construction of new buildings on gas-contaminated land.*

2.2.3 **C2**

In areas subject to radon, the guidance included in the BRE publication, BR 211 (current edition) *Radon; guidance on protective measures for new dwellings*, should be followed.

2.3 UNDERGROUND SERVICES AND DRAINAGE

2.3.1 **C3**

With the agreement of the appropriate statutory authority, any services which are affected by the construction work should be re-routed around the building, or the building and the services should be designed to enable the services to run under the building, again with their agreement.

2.3.2 **C3**

If an active subsoil drain is cut during excavation it should be:

(a) Repaired, and if it is to pass through the building, be re-laid in pipes with sealed joints and have access points outside the building (in accordance with Approved Document C, paragraph 1.6), or

(b) Re-routed around the building, or

(c) Re-run to another outfall.

2.3.3 ***GP***

The building should be orientated and designed to avoid the risk of increasing hydrostatic pressure. Where this is not practicable, the waterproofing system should be designed to withstand a full hydrostatic head, or provisions should be made for roddable subground drainage to control or maintain the external environment for which the water proofing system was designed (Figure 2.1).

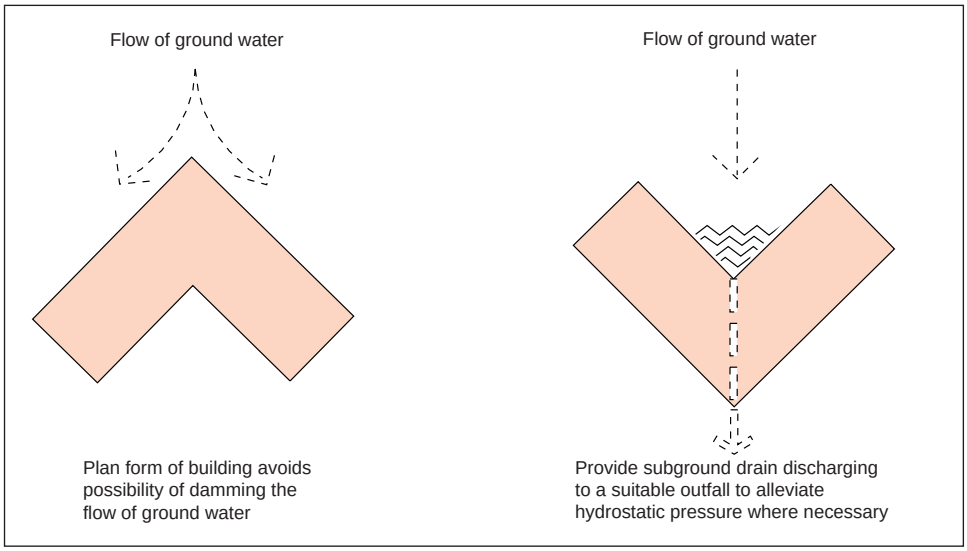


Figure 2.1 Effect of building orientation on flow of ground water

2.4 EXCLUSION OF MOISTURE

2.4.1 **C4** Walls and floors below external ground level and the junctions between them should:

(a) Provide resistance to ground moisture reaching the internal surface of the wall or upper surface of the floor so that the environmental conditions within the basement are appropriate to the intended use.

(b) Not be damaged by moisture from the ground.

Note:

British Standard 8102: 1990 *Code of practice for protection of structures against water from the ground* gives four levels of protection (Grades).

Grade 1 allows some seepage and damp patches and as a result is generally considered inappropriate for dwellings.

Grade 2 allows no water penetration but moisture vapour is tolerated.

Grade 3 again allows no water penetration and provides a dry environment maintained by heating and adequate ventilation.

Grade 4 is for a controlled environment and requires the addition of air conditioning.

2.4.2 ***GP***

Grade 2 is recommended as a minimum for garages, workshops and plant rooms. Grade 3 is recommended for habitable accommodation. Similar wall constructions can be used for Grades 2, 3 and 4 with improvements in dryness being obtained by the degree of heating, ventilation and moisture control provided.

2.4.3 ***GP***

Guidance on the selection of an appropriate form of construction and waterproofing system for a Grade 2 or better level of protection is given in Appendix 2A.

2.4.4 ***GP***

It is advisable to provide ventilation to all basements (heated or unheated) so that any moisture vapour either generated within the dwelling, or brought in through the structure, is adequately controlled. This would then effectively provide a Grade 3 level of protection to all basements if they are heated. Air conditioning would be required to produce a Grade 4 level of protection.

APPENDIX 2A - SELECTING A CONSTRUCTION AND WATERPROOFING SYSTEM

2A.1 This appendix provides guidance on one method of determining an appropriate form of construction and waterproofing; this is given in paragraph 2A.2. More detailed guidance is given in BCA publications *Basement waterproofing: Design guide* and *Basement waterproofing: Site guide*. Other methods and details may be equally appropriate.

2A.2 The steps to be followed are given below and shown in Figure 2A.1.

Step (1) Determine the position of the water table with respect to the underside of the lowest floor level according to the classification as follows:

HIGH	Where the water table or perched water table* is above the underside of the lowest basement floor slab.
LOW	Where the water table or perched water table* is permanently below the underside of the lowest basement floor slab.
VARIABLE	Where the water table varies between the two extremes described above. The length of time during which a particular condition exists will influence the design.

* Perched water table: a reservoir of water in the ground maintained temporarily or permanently above the standing water level in the ground below it, usually caused by the presence of a stratum which is of low permeability or is impervious.

Note:
In order to accurately determine the levels of the ground water table in heavy clays it may be necessary to install standpipes or piezometers. On a clay soil consideration should be given to the water table having been temporarily lowered by seasonal desiccation or the action of trees.

Step (2) Determine the drainage characteristics from analysis of the soil or assess them using Table 2A.1.

Step (3) Determine from Table 2A.2 whether the waterproofing system should be made continuous or whether discontinuity may be acceptable. The principle of continuity of waterproofing is shown in Figure 2A.2. An example of a discontinuity is shown in Figure 2A.3. Make provisions for roddable subground drainage where required to control or maintain the external environment for which the system was designed.

Step (4) Select an acceptable construction type from Figure 2A.4 for established position of water table and permeability characteristics of soil. The three types of basement construction are shown in Figure 2A.5.

Step (5) Determine proposed type of foundation and assess its suitability for providing continuity of waterproofing. Various foundation examples are given in Figure 2A.6.

Step (6) If continuity of the waterproofing is required by step (3) but cannot be obtained with the proposed foundation type, select an alternative foundation so that the waterproofing can be made continuous (Figure 2A.6). Confirm that the selected foundation type and waterproofing can achieve the required water resistance.

Step (7) Assess the range of suitable primary waterproofing systems by reference to Table 2A.3. Account needs to be taken of both the water and any aggressive materials in the soil and/or ground water. Select and confirm the suitability of the waterproofing system for the intended construction and exposure conditions. The system should be installed in accordance with the manufacturer's recommendations. When required, provide protection to the waterproofing system during construction.

Step (8) Ensure adequate waterproofing details are provided for the system in general (eg wall base details, laps in membrane etc), for changes in the level of the slab, at the head of the wall where it adjoins the superstructure, and at window openings which go below ground level. Examples are shown in Figures 2A.7 and 2A.8. Additional details should also be used for any services which penetrate the waterproofed wall (see example shown in Figure 2A.9).

Step (9) The solution is likely to meet the requirements of the Regulations if:

(a) Each item has been considered and adequate account has been taken of the associated factors;

(b) The waterproofing system meets the conditions of its Technical Approval, where relevant;

(c) The design proposals are in accordance with the suppliers' recommendations.

If not, reassess steps (1) to (8) as appropriate.

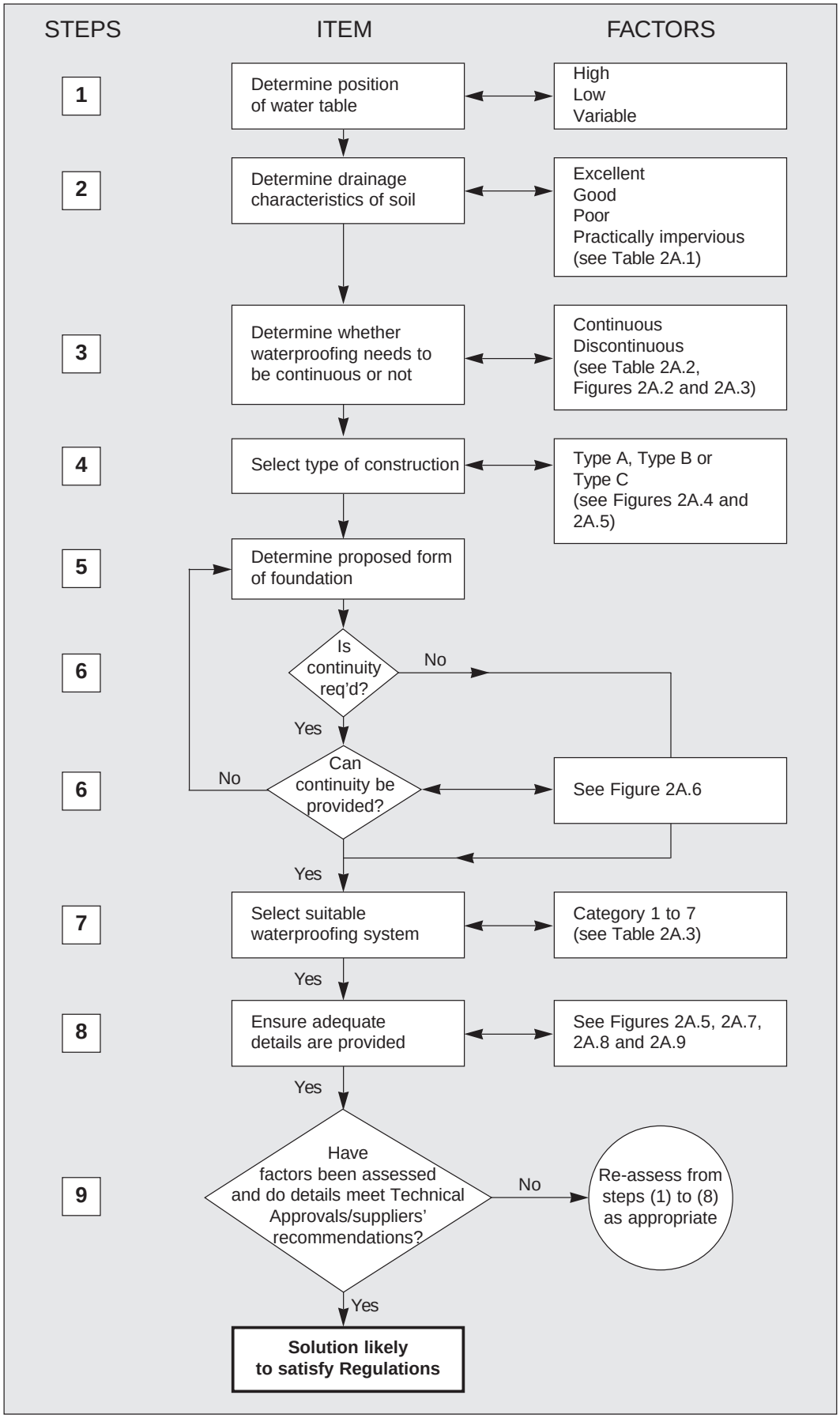


Figure 2A.1 Determining appropriate form of basement construction and waterproofing

Table 2A.1 Characteristics of soils which affect basement construction

Material	Major divisions	Sub-groups	Drainage characteristics	Shrinkage or swelling properties
Coarse soils and other materials	Boulder and cobbles	Boulder gravels	Good	Almost none
	Other materials	Hard: hard broken rock, hardcore, etc.	Excellent	Almost none
		Soft: chalk, soft rocks, rubble	Fair to practically impervious	Almost none to slight
	Gravels and gravelly soils	Well graded gravel and gravel-sand mixtures, little or no fines	Excellent	Almost none
		Well graded gravel-sand mixtures with excellent clay binder	Practically impervious	Very slight
		Uniform gravel with little or no fines	Excellent	Almost none
		Poorly graded gravel and gravel-sand mixtures, little or no fines	Excellent	Almost none
		Gravel with fines, silty gravel, clayey gravel, poorly graded gravel-sand-clay mixtures	Fair to practically impervious	Almost none to slight
	Sands and sandy soils	Well graded sands and gravelly sands, little or no fines	Excellent	Almost none
		Well graded sand with excellent clay binder	Practically impervious	Very slight
		Uniform sands with little or no fines	Excellent	Almost none
		Poorly graded sands, little or no fines	Excellent	Almost none
		Sands with fines, silty sands, clayey sands, poorly graded sand-clay mixtures	Fair to practically impervious	Almost none to medium
Fine soils	Soils having low compressibility	Silts (inorganic) and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Fair to poor	Slight to medium
		Clayey silts (inorganic)	Practically impervious	Medium
		Organic silts of low plasticity	Poor	Medium to high
		Heavily over-consolidated clays independent of plasticity	Practically impervious	Medium to high
	Soils having medium compressibility	Silt and sandy clays (inorganic) of medium plasticity	Fair to poor	Medium to high
		Clays (inorganic) of medium plasticity	Fair to practically impervious	High
		Organic clays of medium plasticity	Fair to practically impervious	High
		Intermediate over-consolidated clays independent of plasticity	Practically impervious	Medium to high
	Soils having high compressibility	Micaceous or diatomaceous fine sandy and silty soils, elastic silts	Poor	High
		Normally consolidated clays (inorganic) of high plasticity, fat clays	Practically impervious	High
		Normally consolidated organic clays of high plasticity	Practically impervious	High
		Normally consolidated and lightly over-consolidated clays independent of plasticity	Practically impervious	High
Fibrous organic soils with very high compressibility		Peat and other highly organic swamp soils	Fair to poor	Very high

Table 2A.2 Requirements for continuity

Position of water table	Drainage characteristics of soil	Can site be drained effectively?	Requirement for waterproofing in soils without gases	Requirement for waterproofing in soils if gases present
Low	Excellent	Yes	Discontinuity might be possible	Needs to be continuous
	Good			
	Fair to poor to practically impervious (see Note)	No	Needs to be continuous	
Variable	Any			
High				

Note:
For discontinuity to be acceptable any water must be able to be drained permanently to a position below the lowest slab level where it cannot back up. This is often possible on sloping sites or where the underlying soil is very free draining. Particular care is needed on poor or practically impervious soils since reliance has to be made on the added drainage being effective over the long term. Where any doubt exists as to the ability to drain water away from the basement structure, or where there is a possibility of a rising water table, then any waterproofing should be made continuous and account taken of the anticipated hydrostatic head.

Table 2A.3 Suitability of primary waterproofing system[1]

Position of water proofing system	Type A construction (tanked protection)	Type B construction (structurally integral protection – eg water-resistant concrete)	Type C construction (internal drained cavity)
External	1, 3, 4, 5, 6, 7	1, 3, 4, 5, 6, 7	
Sandwich	1, 3, 4, 5, 6, 7	1, 3, 4, 5, 6, 7	
Internal	4, 6, 7	4, 6, 7	2
Integral	N/A	In-situ concrete[2]	N/A

Categories of waterproofing systems are:

1. Bonded sheet membranes
2. Cavity drain membranes
3. Bentonite clay active membranes
4. Liquid-applied membranes
5. Mastic asphalt membranes
6. Cementitious crystallization active systems
7. Proprietory cementitious multi-coat renders, toppings and coatings

(Note: these categories are more extensive and differ slightly from those given in BS 8102, but are more commonly used by manufacturers)

Notes:
1. If waterproofing system has to resist aggressive chemicals present in the ground water and/or in the soil, then confirm its suitability with the manufacturer. Some systems will need rendering in order for the waterproofing to be effective.
2. Additional protection may be provided to improve water resistance, or may be required under aggressive soil conditions.

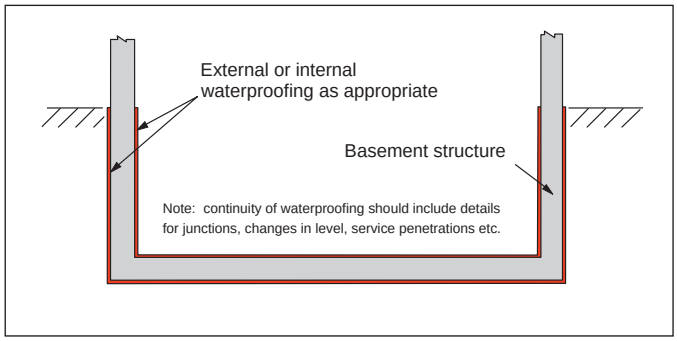


Figure 2A.2 Continuous waterproofing to basement

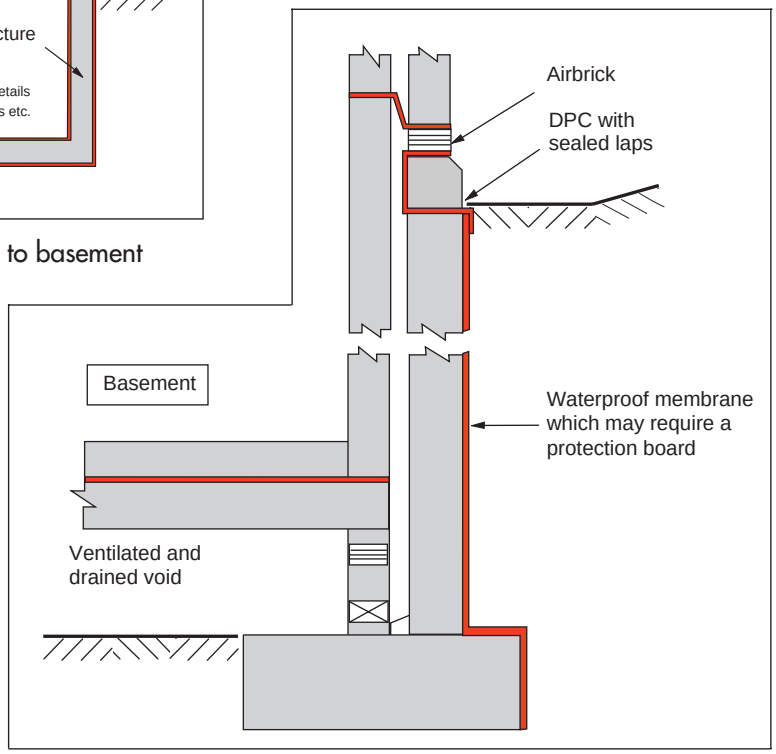


Figure 2A.3 Discontinuity of waterproofing on free-draining site

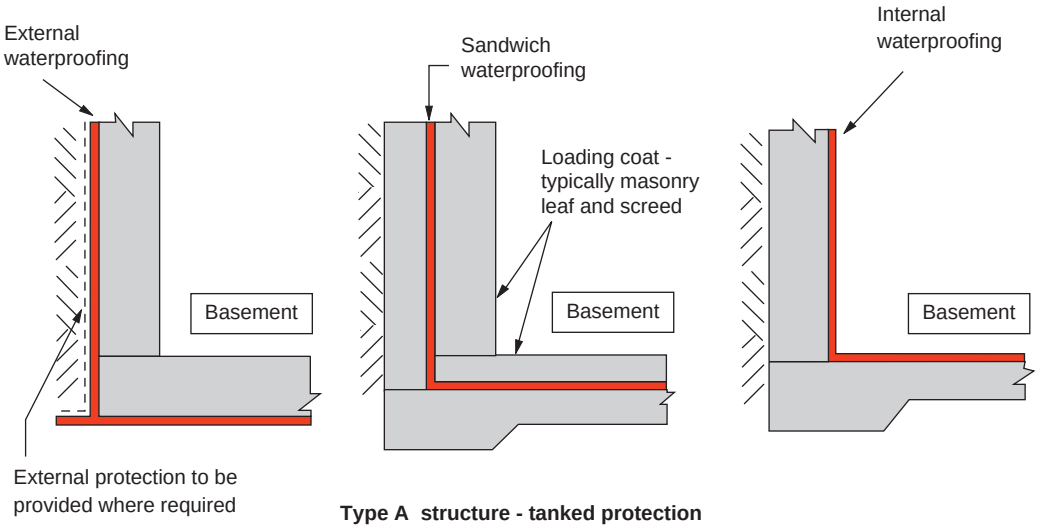
Water table	Type A construction (Tanked protection)		Type B construction (Structurally integral protection: water-resistant concrete)				Type C construction (Drained cavity)	
	Water-proofing	Plus drainage	BS 8110	Plus water-proofing	BS 8007	Plus water-proofing	BS 8110 Plus moisture barrier	BS 8007 Plus moisture barrier
Low (soil permeability may affect risk)	✓	✓	✓	✓	✓	✓	✓	✓
Variable (subject to prevailing soil conditions)	See Note 2			✓	✓	✓	✓	✓
High	NOT RECOMMENDED			✓ See Note 1	✓	✓ See Note 1	✓	✓

ACCEPTABLE CONSTRUCTION

Decreasing risk of moisture penetration

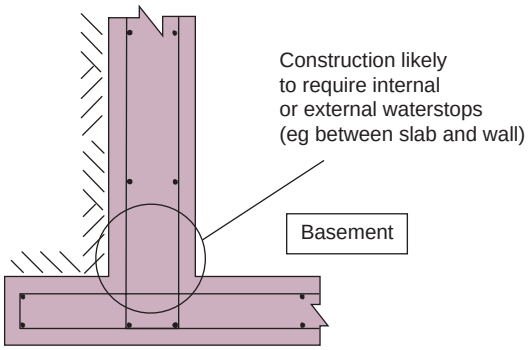
Notes:
1. In high water table conditions the effectiveness of the additional waterproofing system will depend on its application and bond characteristics when permanently under water. (Seek manufacturer's advice.)
2. Constructions may produce acceptable solutions when variability is due to surface water or other infrequent occurrence and not due to an actual rise in water table. (Seek manufacturer's advice.)

Figure 2A.4 Acceptability of construction types



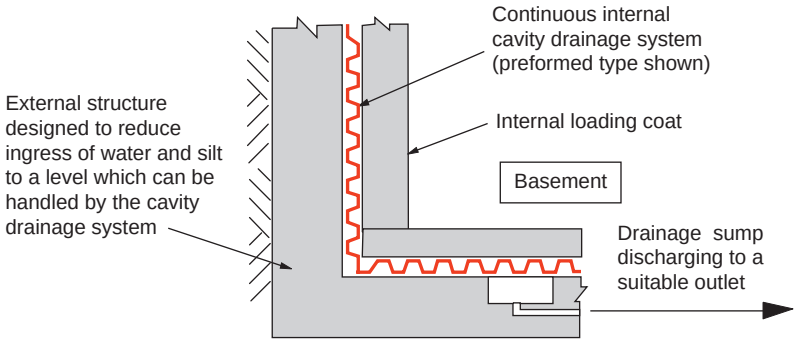
Type A structure - tanked protection

(water resistance reliant on waterproofing)



Type B structure - structurally integral protection (water-resistant concrete)

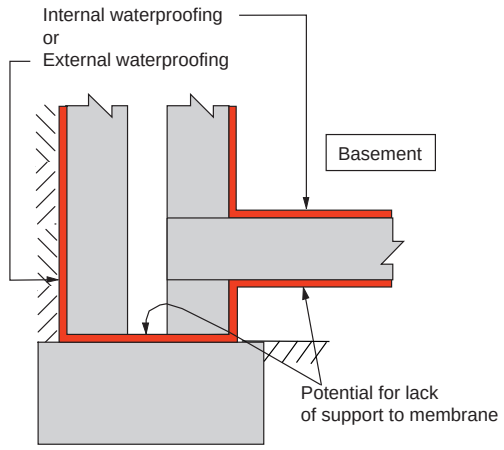
(water resistance reliant specifically on the the concrete construction but may be combined with additional waterproofing)



Type C structure - drained cavity

(water resistance reliant on collecting any water within internal cavity system)

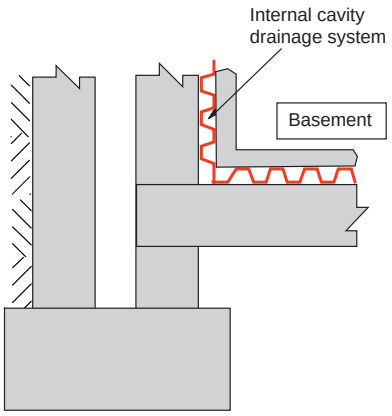
Figure 2A.5 The three types of basement construction



Type A structure

(a) Strip foundation without starter bars

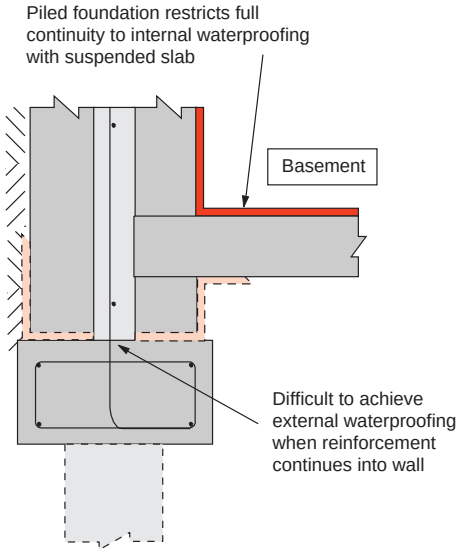
Can be suitable where continuity of waterproofing is required.
Due to possibility of movement, a ground-supported slab should only be used where discontinuity is acceptable.



Type C structure

(b) Strip foundation without starter bars

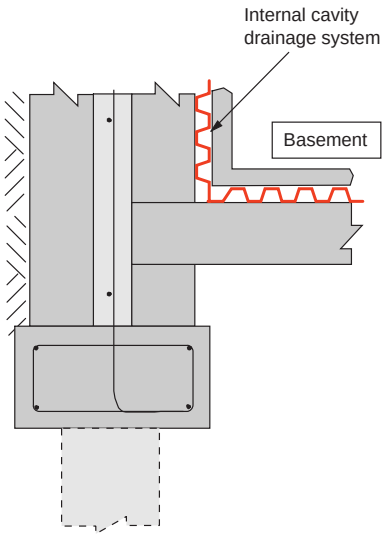
Can be suitable where continuity of waterproofing is required.
Due to possibility of movement, a ground-supported slab should only be used where discontinuity is acceptable.



Type A structure

(c) Strip or piled foundation with starter bars

Can be suitable where continuity of waterproofing is required.
Due to the possibility of movement, a ground-supported slab should only be used where discontinuity is acceptable.



Type C structure

(d) Strip or piled foundation with starter bars

Can be suitable where continuity of waterproofing is required.
Due to possibility of movement, a ground-supported slab should only be used where discontinuity is acceptable.

Figure 2A.6 Effect of foundation design on continuity of waterproofing

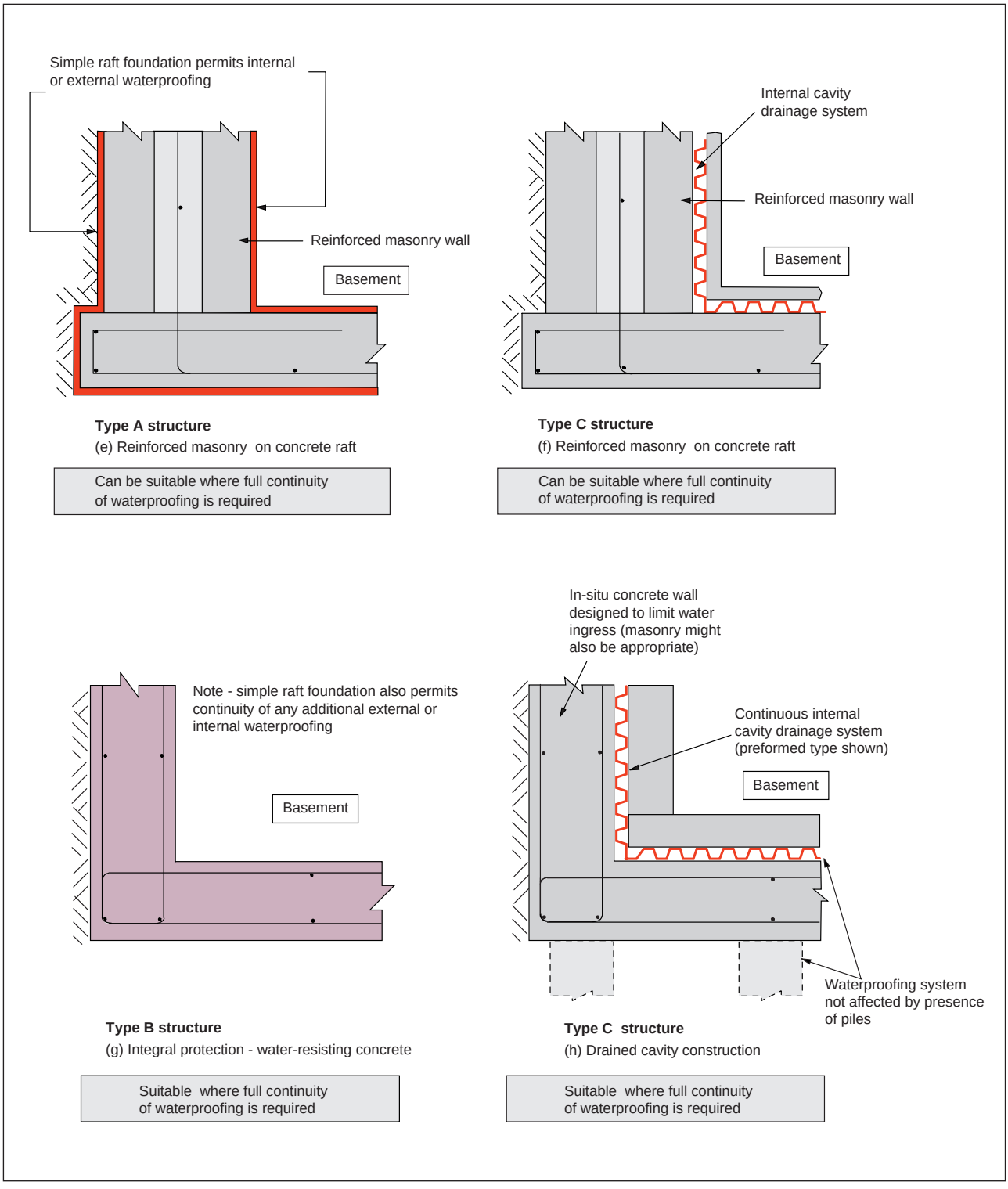
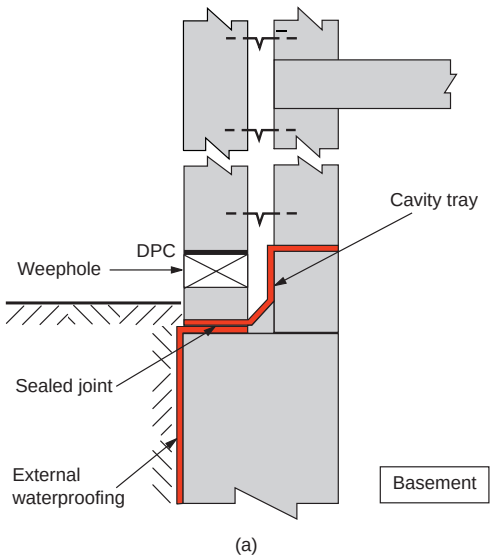
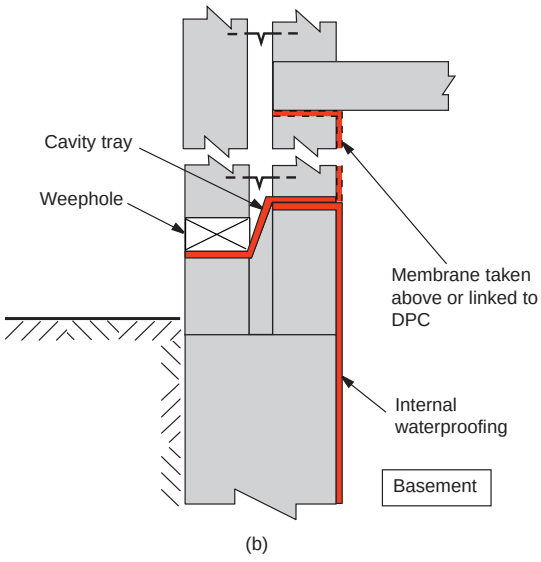
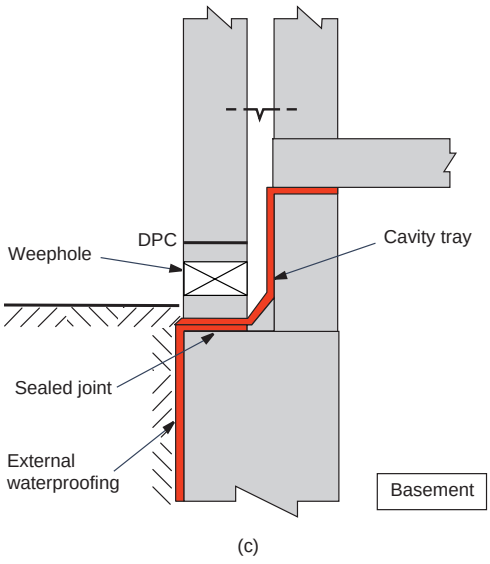


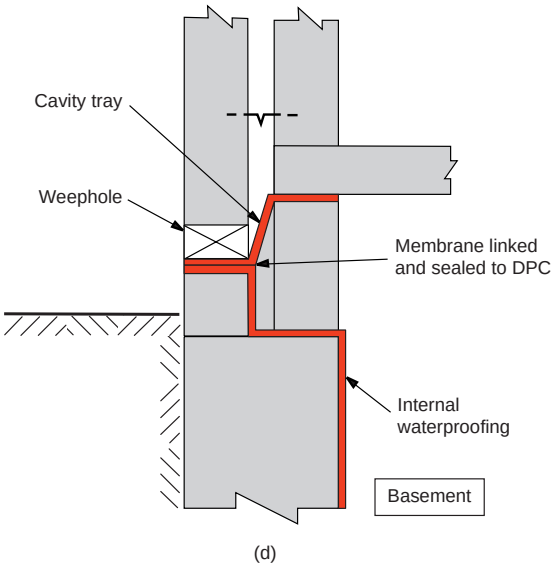
Figure 2A.6 Effect of foundation design on continuity of waterproofing (continued)





Examples of linking waterproofing with DPC/cavity tray where wall ties are required due to height of internal floor above ground level





Examples of linking waterproofing with DPC/cavity tray where there are no wall ties

Figure 2A.7 Continuity of waterproofing – linking with superstructure

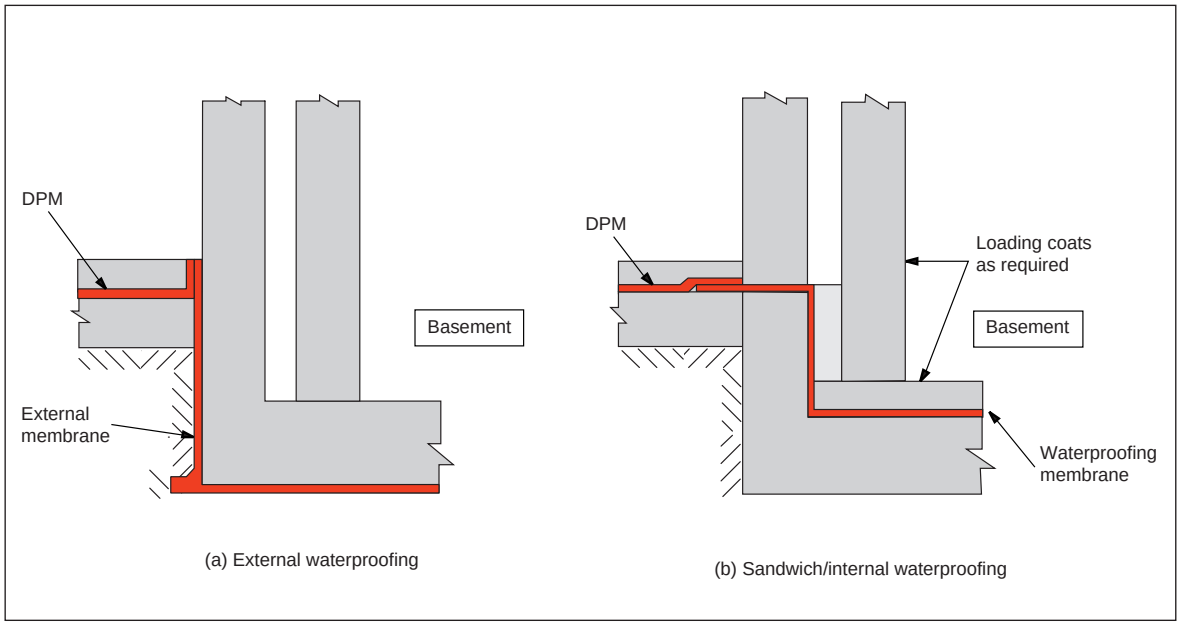


Figure 2A.8 Continuity of waterproofing – step changes in construction

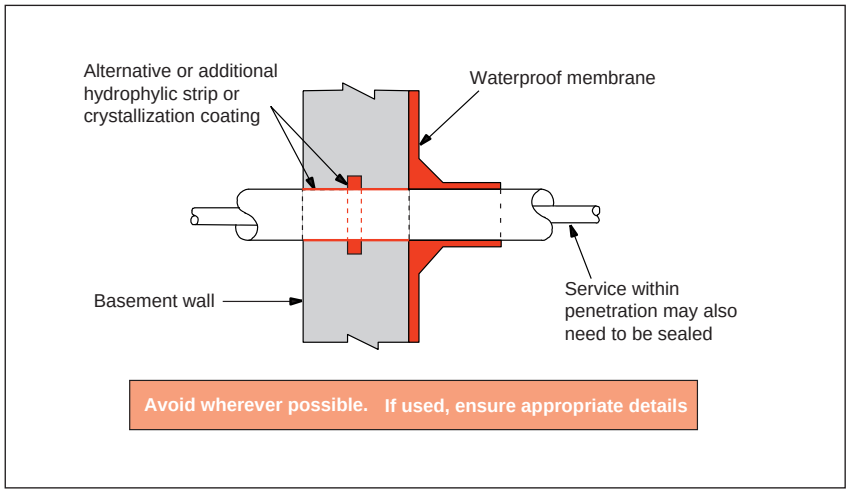


Figure 2A.9 Penetration of services through waterproofing

3 STRUCTURE

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part A of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document A should also be followed or the requirements should be met in some other way.

REQUIREMENT	LIMITS ON APPLICATION
A1 LOADING (1) The building shall be constructed so that the combined dead, imposed and wind loads are sustained and transmitted by it to the ground – (a) safely; and (b) without causing such deflection or deformation of any part of the building, or such movement of the ground, as will impair the stability of any part of the building. (2) In assessing whether a building complies with sub paragraph (1) regard shall be had to the imposed and wind loads to which it is likely to be subjected in the ordinary course of its use for the purpose for which it is intended.	
A2 GROUND MOVEMENT The building shall be constructed so that ground movement caused by – (a) swelling, shrinkage or freezing of the subsoil; or (b) land-slip or subsidence (other than subsidance arising from shrinkage), in so far as the risk can be reasonably foreseen, will not impair the stability of any part of the building.	
A3 DISPROPORTIONATE COLLAPSE The building shall be constructed so that in the event of an accident the building will not suffer collapse to an extent disproportionate to the cause.	Requirement A3 applies only to a building having five or more storeys (each basement level being counted as one storey) excluding a storey within the roof space where the slope of the roof does not exceed 70º to the horizontal.

3.1 INTRODUCTION

3.1.1 **A1** The requirements of A1, in respect of dwellings with basements, will be met by adopting:

(a) The provisions of Approved Document A (Section 1 or by following the recommendations given in the documents listed in Section 4) for elements **not** required to resist the effects of lateral earth loads; and

(b) The provisions of this section together with Appendices 3A, 3B and 3C, or 3D alone of this document for elements that **are** required to resist the effects of vertical and/or lateral earth loads and lateral loads due to surcharge.

Appendices 3A to 3D give guidance as follows:

- Appendix 3A gives requirements for **reinforced masonry retaining walls** for certain residential buildings where the water table is below the underside of the basement floor slab and where the material being retained is a soil of Type II, III, IV or V as in Table 12 of Approved Document A, in a drained condition.
- Appendix 3B gives requirements for **reinforced in-situ concrete retaining walls** for certain residential buildings where the water table is below the underside of the basement floor slab and where the material being retained is a soil of Type II, III, IV or V as in Table 12 of Approved Document A, in a drained condition.
- Appendix 3C gives requirements for **reinforced and plain concrete foundations** for certain residential buildings.
- Appendix 3D is relevant to **all dwellings** and lists Codes, Standards and other references for structural design and construction but, where they do not give precise guidance, consideration should be given to paragraph 3.1.2. Appendix 3D is also relevant where the water table is above the underside of the basement floor slab, making it necessary to take account of the effect of water pressure on both walls and basement floor. Under these conditions the number of variables in loads and spans is such that guidance cannot be given in Appendices 3A and 3B.

3.1.2 **A1** The safety of a structure depends on the successful combination of design and construction as explained in the Introduction to Approved Document A.

3.1.3 **A1** In formulating the guidance in Appendices 3A, 3B and 3C the worst combination of circumstances likely to arise was taken into account. If a requirement of this part is considered too onerous in a particular case, it may be appropriate to consider a minor departure on the basis of judgement and experience, or to show adequacy by calculation in respect of the aspect of the wall or foundation which is subject to the departure rather than for the entire wall or foundation.

3.1.4 **A1** It is a provision of this section that its content is considered by appropriately qualified persons and that the execution of the work is carried out under the direction of appropriately qualified supervisors.

3.2 DEFINITIONS

3.2.1 **A1** The following meanings apply to terms throughout this section and its Appendices.

Bar spacing The distance between the longitudinal centres of any two adjacent reinforcing bars measured in the plane of the floor or wall.

Buttressing wall A wall designed and constructed to afford lateral support to another wall perpendicular to it, support being provided from the base to the top of the wall.

Cantilevered retaining wall A wall relying on restraint moment at its base to provide lateral support to the ground.

Clay soil Soil containing more than 35% fines (clay and silt particles). (Limited to soil Types II, III, VI or V for the purpose of this section.)

Dead load The load due to the weight of all walls, permanent partitions, floors, roofs, finishes including services, and all other permanent construction.

Earth loads The loads assumed to be produced by the soil and/or ground water.

Granular soil Soil containing less than 35% fines (clay and silt particles). (Limited to soil Types II, III, VI or V for the purpose of this section.)

Grouted cavity width The horizontal distance between the two leaves of a grouted-cavity masonry wall.

High-lift construction The method of constructing grouted-cavity masonry walls where the infill concrete is placed and compacted in a wall built to its full height but not exceeding 3 m.

Imposed load The load assumed to be produced by the intended occupancy or use, including the weight of moveable partitions, and distributed, concentrated, impact, inertia and snow loads, but excluding wind loads.

Low-lift construction The method of constructing grouted-cavity masonry walls where the infill concrete is placed and compacted in layers, not exceeding 450 mm, to within 50 mm of the last course laid.

Propped cantilevered retaining wall A wall, supporting a lateral load due to earth loads, which resists the moment at its base, is propped by an upper floor within the storey height and has sufficient strength and stiffness to transfer forces to the supporting floor.

Span The distance measured along the centre line of a member between the centres of any two adjacent bearings or supports.

Supported wall A wall to which lateral support is afforded by a combination of buttressing walls or piers acting in conjunction with floor(s).

Surcharge loads Vertical loads applied to the surface of the ground due to people, vehicles or materials. (Such loads can increase lateral pressures on retaining walls.)

Well drained soil Soil in which the pore pressures can be taken as zero, ie where the water table is below the underside of the foundation level. This does not mean that the soil, either 'granular' or 'clay', is dry.

3.3 APPLICATION

3.3.1 **A1** This section and appendices 3A, 3B and 3C apply to residential buildings measured in accordance with paragraph 3.5.1, and can also apply to small single-storey non-residential buildings, and small buildings forming annexes to residential buildings (including garages and outbuildings).

3.4 WALL TYPES

3.4.1 **A1** Only retaining walls as limited in Table 3.1 are considered in this section and in Appendices 3A, 3B and 3C.

3.4.2 **A1** Walls which extend for the full height of the storey and which are supported by a floor complying with paragraph 3.10 may be designed as a propped cantilever.

3.4.3 **A1** Walls not having a top support (as at a window opening), or where the wall has insufficient strength to transfer forces to an upper supporting floor, or where the floor is incapable of supporting the wall, should be designed as a simple cantilever.

3.4.4 **A1** Walls which are taken as being propped by a floor should not be backfilled before the floor has been installed and is capable of propping the wall; this may require part of the superstructure above ground to be completed (paragraph 3.10).

Table 3.1 Minimum thickness and maximum dimensions of retaining walls

Height of storey	Minimum thickness of wall
Not exceeding 2.7 m	200 mm or 300 mm, as determined from Appendices 3A and 3B

3.5 CONDITIONS RELATING TO THE BUILDING OF WHICH THE WALL FORMS PART

3.5.1 **A1** This section applies only to buildings having proportions within the parameters given in Section 1C, Paragraph 1C14 of Approved Document A, and as given in Figure 3.1.

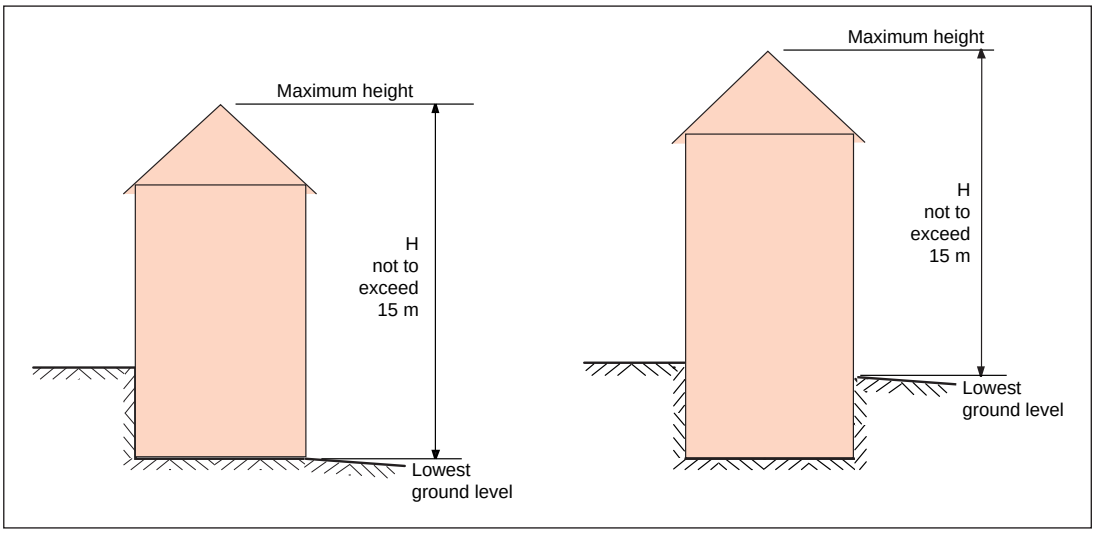


Figure 3.1 Maximum height of residential buildings

3.5.2 **A1** The basement structure should not exceed one storey height.

3.5.3 **A1** The guidance of this section follows that of Approved Document A, Section 1C, 'maximum floor area', in that no floor enclosed by structural walls on all sides exceeds 70 m^2; and that no floor without a structural wall on one side exceeds 30 m^2.

3.6 CONDITIONS RELATING TO THE ALLOWABLE LENGTH AND HEIGHT OF THE RETAINING WALL

3.6.1 **A1** The maximum allowable storey height of the wall (h_1) containing the retaining wall should not exceed 2.7 m, measured from the top of the basement floor to the underside of the floor over the basement storey. The maximum allowable retained height (h) should not exceed 2.7 m measured from the top of the foundation (strip footing or raft foundation) to ground immediately adjacent to the wall (Figure 3.2).

3.6.2 **A1** The maximum allowable storey and wall heights of other walls within the building should be in accordance with Approved Document A, Section 1C, 'Rules of measurement for heights of walls and storeys' (Figure 3.2.).

3.7 LOADING ON WALLS

3.7.1 **A1** The loading due to vertical loads onto retaining walls should not exceed 70 kN/m at the base of the wall (Figure 3.2).

3.7.2 **A1** Vertical loading on walls should be distributed. This may be assumed for concrete floor slabs, precast concrete floors and timber floors designed in accordance with the provisions of Approved Document A, Section 1C, paragraph 1.C.25 'Other load conditions'.)

3.7.3 **A1** The lateral loadings taken for this section relate to well drained soils of types II, III, IV or V.

Note:
Where the water table is above the underside of the basement floor slab, additional forces will act on both walls and floor and could induce uplift. Such conditions are outside the scope of this section and reference should be made to Appendix 3D.

3.7.4 **A1** Except in the case of drive or parking area solely serving an individual dwelling, a retaining wall should not be closer to a road or other trafficked area than a distance equal to 1.5 times the depth of the basement below ground level (Figure 3.3).

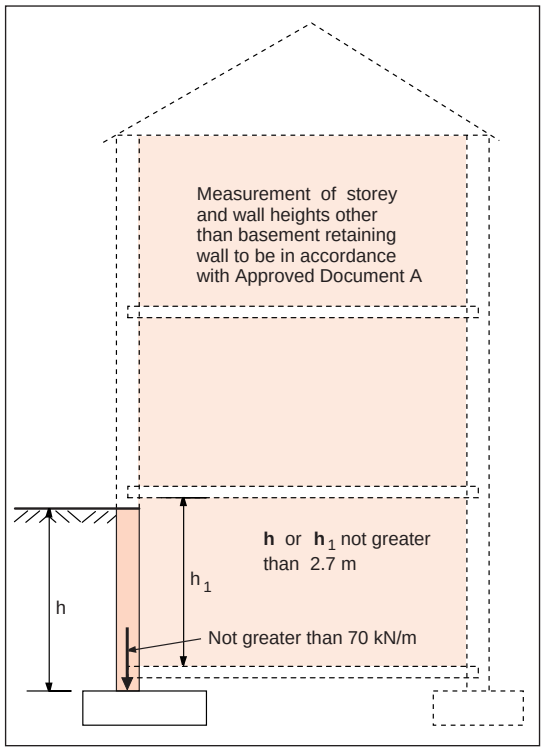


Figure 3.2 Measuring and limitation on height of basement wall

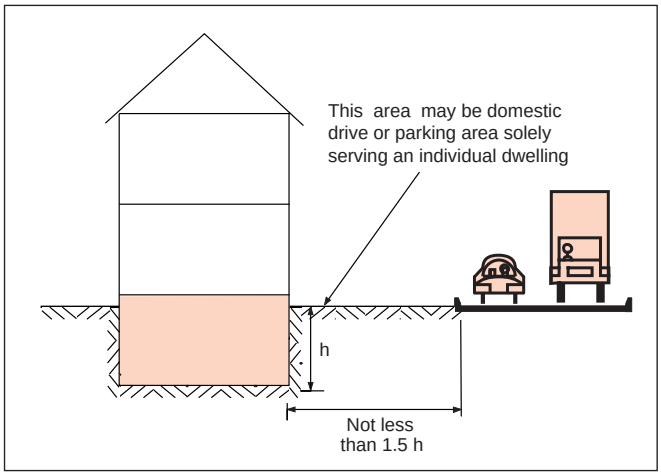


Figure 3.3 Distance of road from basement

3.7.5 **A1** The difference in level of ground or other solid construction between one side of an unreinforced wall and the other should be not greater than four times the thickness of the wall (Diagram 14, 'Differences in ground level' in Approved Document A).

3.7.6 **A1** When constructing a basement in desiccated clays or in shrinkable soils near trees (or in areas where trees are scheduled to be removed) there may be a risk of subsequent swelling of the soil. In such circumstances precautions should be taken either to withstand or to absorb any lateral pressures which may be applied to the walls.

3.8 END RESTRAINT

3.8.1 **A1** Ends of walls in a basement should be provided with restraint when sized in accordance with the provisions of Approved Document A.

3.8.2 **A1** All external walls (other than retaining walls) and internal walls should be in accordance with the provisions of Approved Document A.

3.9 OPENINGS, OVERHANGS AND CHASES

3.9.1 **A1** The number, size and position of openings (eg for window lightwells and door access ways) in a basement retaining wall should not impair its stability. Construction over openings should be adequately supported.

3.9.2 **A1** The dimensional criteria for openings are given in Figure 3.4; they are a modification to those given in paragraph 1C30 of Approved Document A.

3.9.3 **A1** Any chases should be limited as follows:

(a) Vertically not deeper than 15 mm.

(b) Horizontally not deeper than 15 mm and not more than 600 mm in length between any pair of vertical restraint walls.

(c) No chase should impair the stability of the wall.

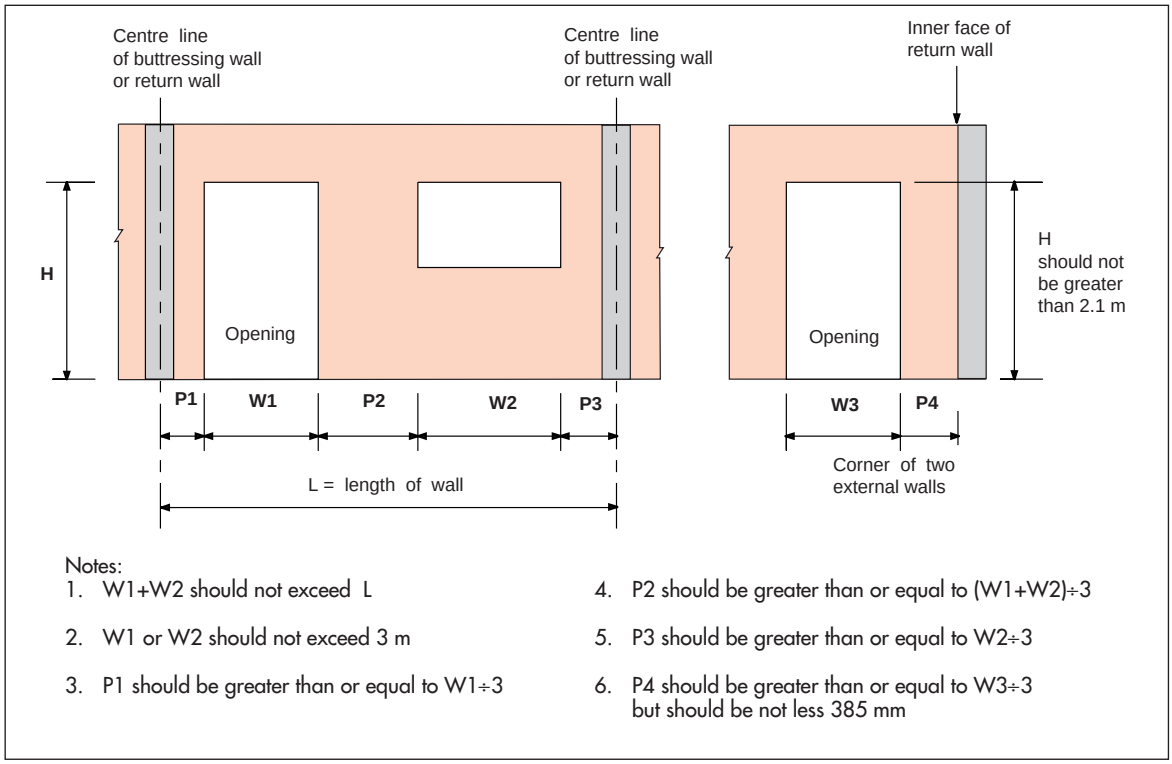


Figure 3.4 Sizes of openings

3.9.4 **A1** The amount of any projection should not impair the stability of the wall.

3.10 LATERAL SUPPORT BY FLOORS

3.10.1 **A1** A wall designed as a propped cantilever (Tables 3A.2 and 3B.1) should extend to the full height of the storey, at which level it should have horizontal lateral supports to restrict movement of the wall at right angles to its plane. Such support should:

(a) Act to transfer lateral forces from the wall to buttressing walls or piers capable of resisting the applied lateral load, and

(b) Be secured to the supported wall by adequate connections.

3.10.2 **A1** The requirements of paragraph 3.10.1 for horizontal lateral supports may be taken as being provided by either an in-situ concrete or precast concrete floor which tightly butts against the retaining wall (Figure 3.5(a)), or is tightly butted into a recessed bearing of at least 90 mm along the top of the retaining wall (Figure 3.5(b)). Alternatively, where the vertical load (dead load only, from wall and/or floor) acting on the retaining wall, at the level of the underside of the floor, is not less than 20 kN/m for a wall retaining a granular soil or 30 kN/m for a wall retaining other soils, horizontal lateral support can be taken as being provided by any of the following:

(a) An in-situ concrete or precast concrete floor which has a bearing of at least 90 mm continuously along the top of the retaining wall (Figure 3.5c));

(b) An in-situ concrete or precast concrete floor which has a bearing of at least 90 mm intermittently along the top of the retaining wall and solidly butts against the wall between the intermittent bearing (Figure 3.5(d));

(c) An in-situ or precast concrete floor which has no bearing, but tightly butts against and is tied - at not more than 2 m centres - to the wall supported by the retaining wall with galvanised mild steel straps, which have a minimum cross-section of 30 mm by 5 mm (Figure 3.5(e)).

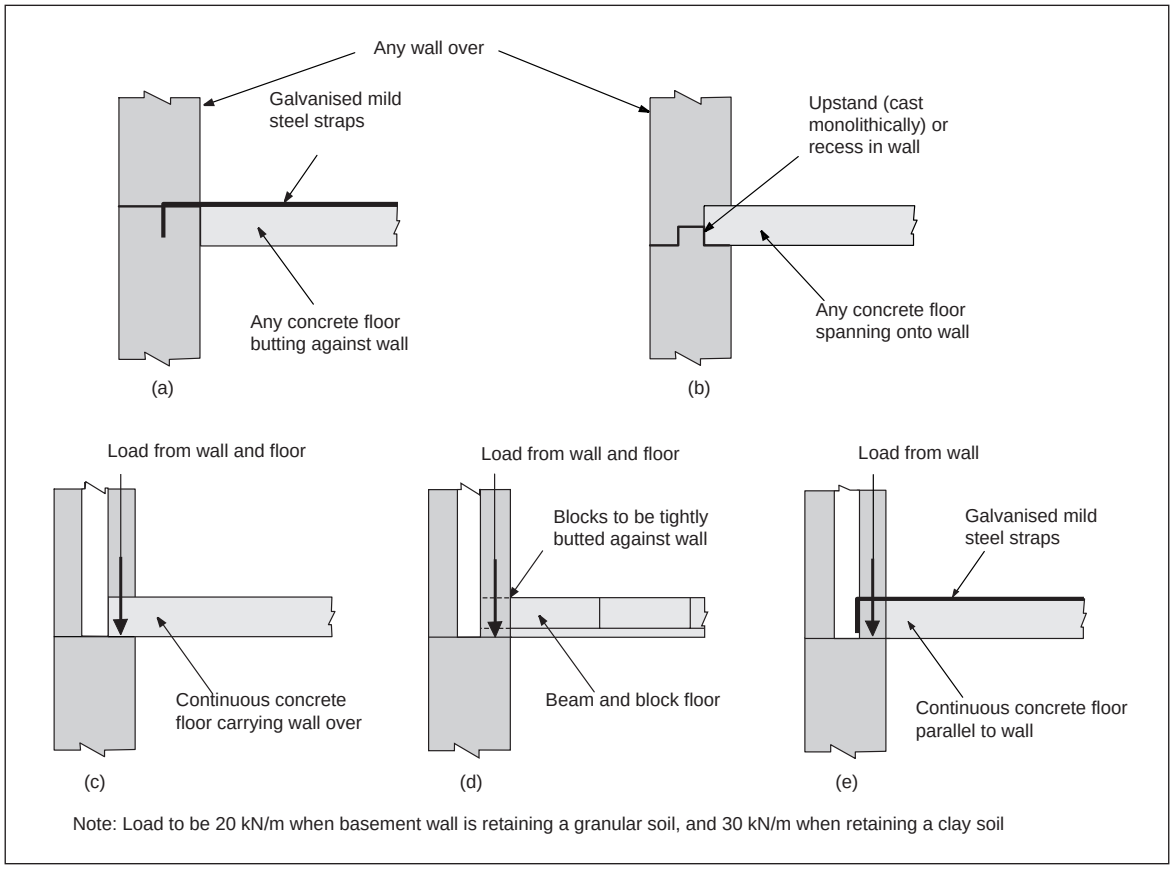


Figure 3.5 Lateral support by floors

3.10.3 **A1** Any floor in paragraph 3.10.2 must be so constructed to provide a rigid plate without undue movement or deflection and have adequate durability.

3.10.4 **A1** A normal timber floor should not be used for support to a propped cantilever wall complying with Appendix 3A or 3B.

3.10.5 **A1** In any floor meeting the requirements of paragraphs 3.10.1 and 3.10.3, the distance between the supporting wall and any staircase or other significant opening should be not less than half the length (measured parallel to the wall) of the opening. In the floor between the wall and the staircase (or other significant opening), there should be no opening greater than 300 mm x 300 mm, and no more than two such openings (Figure 3.6).

3.10.6 **A1** Where a floor is providing lateral support to a wall carrying only vertical loads, and/or lateral loads caused by wind pressure, or to a retaining wall which is designed to be unpropped, then the lateral restraint and connections need only comply with Approved Document A, paragraphs 1C35 to 1C36.

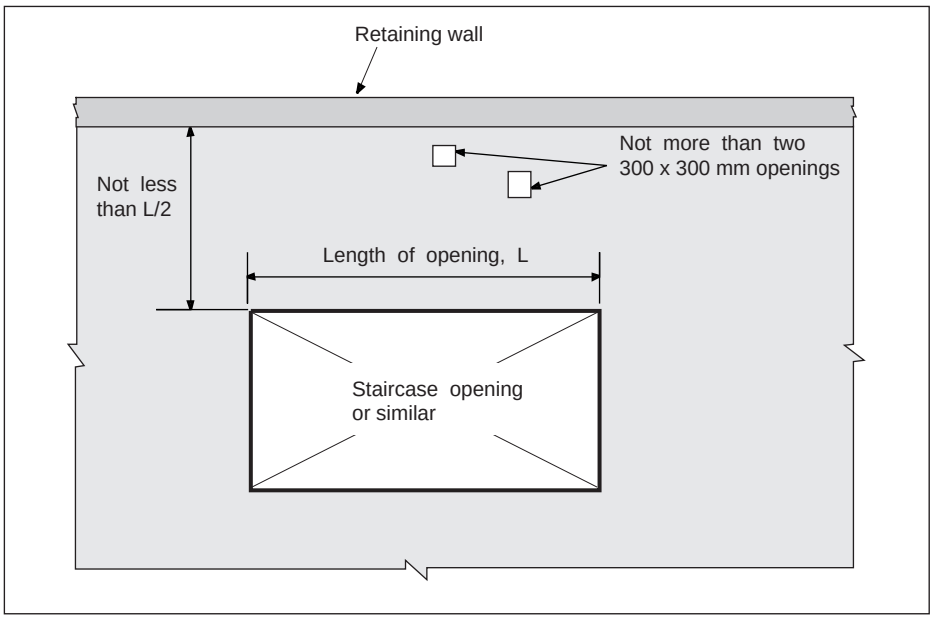


Figure 3.6 Openings in supporting floor

3.11 REQUIREMENTS FOR STRUCTURAL ELEMENTS

3.11.1 **A1** The sizing of structural elements (Figure 3.7) for dwellings carrying lateral earth loads or lateral earth loads together with vertical loads may be determined from:

(a) Appendix 3A which gives sizes of reinforced masonry wall elements.
(b) Appendix 3B which gives sizes of reinforced in-situ concrete wall elements.
(c) Appendix 3C which gives sizes of structural foundations of plain and reinforced concrete.
(d) Appendix 3D which gives design codes and standards.

3.11.2 Approved Document A may be used, subject to its limitations, to determine the size and compressive strength of bricks and blocks required in walls of the dwelling, other than basement retaining walls.

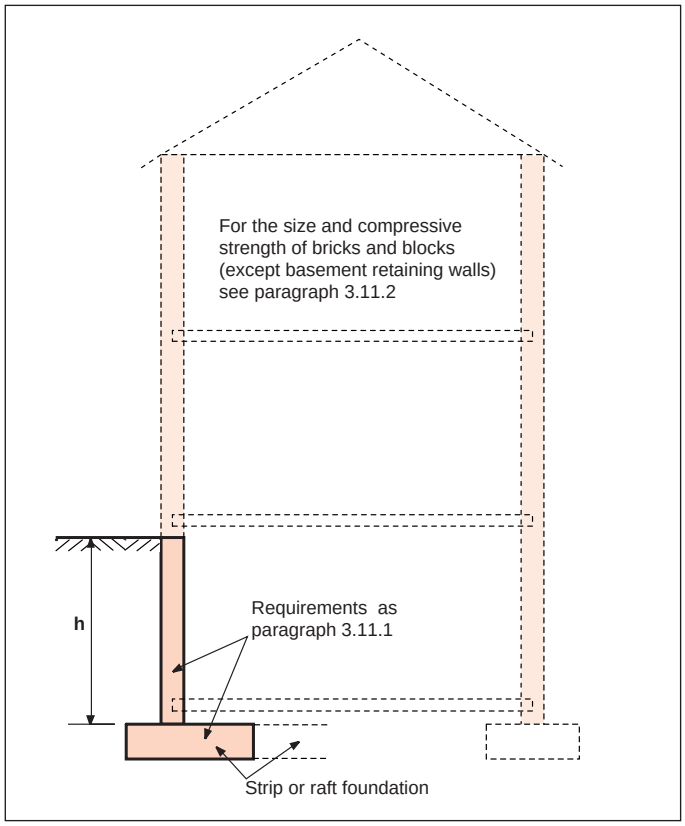


Figure 3.7 Requirements for structural elements

APPENDIX 3A - MASONRY RETAINING WALLS

3A.1 THE USE OF THIS APPENDIX

3A.1.1 **A1** When using this appendix it should be noted that:

(a) It must be used in conjunction with Section 3;

(b) If wall thickness is to be determined according to paragraph 3A.2, all appropriate design conditions given in this appendix must be satisfied;

(c) Walls should comply with the relevant requirements of BS 5628: Part 3: 1985, with the exception of the conditions given in paragraphs 3A.3 to 3A.12;

(d) The guidance is based upon the compressive strengths of bricks and blocks of:

i. Bricks, 20 N/mm^2,

ii. Blocks, 7 and 10 N/mm^2,

depending on circumstances (paragraph 3A.3.7);

(e) The guidance is also based on the provision of reinforcement in accordance with Tables 3A.2, 3A.3 and 3A.4.

3A.2 THICKNESS OF WALLS

3A.2.1 **A1** General wall thickness and reinforcement may be determined according to this appendix provided that:

(a) The conditions relating to the building of which the wall forms a part (paragraph 3.5), and

(b) The conditions relating to the wall (see Table 3.1 and paragraphs 3.6 to 3.11),

are met.

3A.2.2 **A1** All reinforced masonry grouted-cavity retaining walls should have leaves each at least 100 mm thick and a grouted cavity of at least 100 mm wide. For width of cavity and maximum spacing of wall ties refer to Table 3A.1. For specification of wall ties refer to paragraphs 3A.3.1 and 3A.3.2.

3A.3 CONSTRUCTION MATERIALS AND WORKMANSHIP

3A.3.1 **A1** Wall ties for use with grouted-cavity retaining walls constructed using the low-lift method of concrete filling should comply with BS 1243 or meet the recommendations of DD 140: Part 2, Type 1 or 2, or be of other not less suitable type. Wall ties for use with grouted-cavity retaining walls constructed using the high-lift method of concrete filling should be of 6 mm diameter reinforcement, as specified in paragraph 3A.3.3, and bent to the shape and size shown in Figure 3A.1 or be of other not less suitable type.

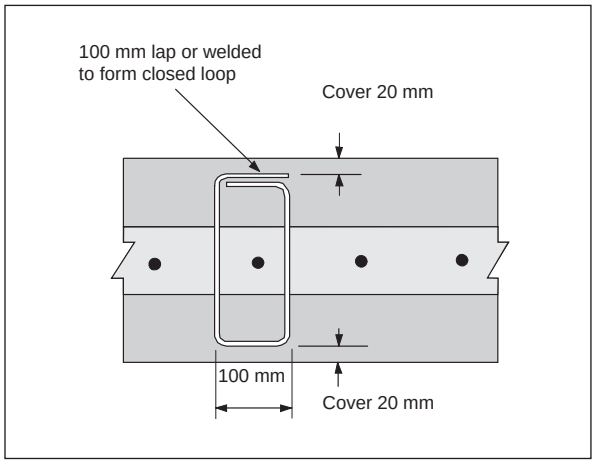


Figure 3A.1 Wall tie for high-lift grouted-cavity wall

Table 3A.1 Maximum spacing of wall ties

Width of grouted cavity (mm)	Construction method	Horizontal spacing (mm)	Vertical spacing (mm)	Other comments
100 - 150	Low-lift	900	450	See notes 1, 2, 3 and 5
	High-lift	900	300	See notes 2, 4 and 5

Notes:
1. The horizontal and vertical spacing of wall ties may be varied if necessary to suit the construction, provided that the density (number of ties per square metre) is not less than 2.5 ties/m^2.
2. Wall ties spaced not more than 300 mm apart vertically should be provided within 225 mm from the sides of all openings with unbonded jambs.
3. Wall ties should be of the vertical twist type to BS 1243, or type 1 or 2 in accordance with DD 140: Part 2.
4. Wall ties should be of the type shown in Figure 3A.1, or of equivalent performance.
5. Each layer of wall ties should be staggered by 450 mm.

3A.3.2 **A1** The wall ties indicated in paragraph 3A.3.1 should be galvanised following the procedure given in BS 729 and have a minimum mass of zinc coating of 940 kg/m^2, except in exposure situations given in paragraphs 3A.3.4 (b) and 3A.3.4(c) where they should be austenitic stainless steel or suitable non-ferrous material.

3A.3.3 **A1** The reinforcement for reinforced masonry grouted-cavity walls should be Grade 460 deformed bars and the wall ties in paragraph 3A.3.1 should be Grade 250, complying with BS 4449, BS 6744 (steel types 304S31 and 316S33), or BS 970 (steel types 304S15, 304S31 and 316S33) as appropriate.

3A.3.4 **A1** The reinforcement indicated in paragraph 3A.3.3 should:

(a) In buried masonry and masonry continually submerged in fresh water or external parts built where the exposure category given in Table 10 of BS 5628: Part 3: 1985 is 'Sheltered/moderate' or 'Moderate/severe', be of carbon steel;

(b) In masonry exposed to freezing whilst wet, subjected to heavy condensation, or exposed to cycles of wetting by fresh water and drying out, or external parts built where the exposure category given in Table 10 of BS 5628: Part 3: 1985 is 'Severe' or 'Very severe', be of carbon steel galvanised following the procedure given in BS 729 to give a minimum mass of zinc coating of 940 kg/m^2;

(c) In masonry exposed to salt or moorland water, corrosive fumes, abrasion or the salt used for de-icing, be of austenitic stainless steel or carbon steel coated with at least 1 mm of stainless steel.

3A.3.5 **A1** As an alternative in the exposure condition given in 3A.3.4 (b), the reinforcement may be of carbon steel where the infill concrete given in 3A.3.16 is not less than that given by a RC35 designated mix to BS 5328: Part 2.

3A.3.6 **A1** The leaves of brick and block construction should be properly bonded and solidly put together with mortar and constructed of:

(a) Clay bricks or blocks conforming to BS 3921: 1985; or

(b) Calcium silicate bricks conforming to BS 187: 1978 or BS 6649: 1985; or

(c) Concrete bricks or blocks conforming to BS 6073: Part 1: 1981.

3A.3.7 **A1** The compressive strength of bricks and blocks, when tested in accordance with the appropriate British Standard, should be not less than the values given in Tables 3A.2, 3A.3 or 3A.4.

3A.3.8 **A1** Vertical reinforcement should be provided in accordance with Tables 3A.2, 3A.3 or 3A.4.

Table 3A.2 Minimum masonry and reinforcement requirements for propped wall retaining a maximum of 2.7 m of soil

Foundation type	Soil type (well drained)	Vertical load (kN/m) up to	Moment taken as acting at base of wall (kN/m)	Block compressive strength (N/mm^2)	Brick compressive strength (N/mm^2)	Area of reinforcement, *As* (mm^2/m)
Raft	Clay and granular	70	20	10	20	620
		50	15	7	20	460
		30	10	7	20	280
Strip	Clay	70	17	7	20	530
	Granular		12	7	20	340

Table 3A.3 Minimum masonry and reinforcement requirements for cantilevered (unpropped) wall retaining a maximum of 2.1 m of soil

Soil type (well drained)	Moment taken as acting at the base of wall (kN/m)	Block compressive strength (N/mm^2)	Brick compressive strength (N/mm^2)	Area of reinforcement, *As* (mm^2/m)
Clay	20	10	20	620
Granular	15	7	20	460

Table 3A.4 Minimum masonry and reinforcement requirements for cantilevered (unpropped) wall retaining a maximum of 1.6 m of soil

Soil type (well drained)	Moment taken as acting at the base of wall (kN/m)	Block compressive strength (N/mm^2)	Brick compressive strength (N/mm^2)	Area of reinforcement, *As* (mm^2/m)
Clay	10	7	20	260
Granular	7	7	20	180

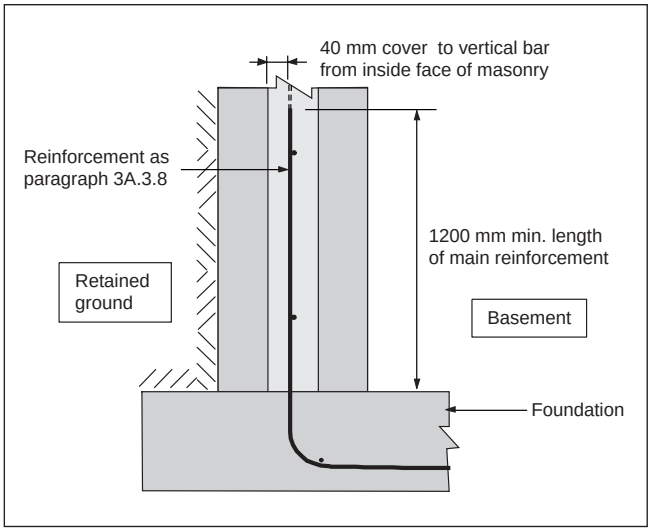


Figure 3A.2 Positioning of reinforcement in grouted-cavity basement wall

3A.3.9 **A1** The reinforcement should be adequately supported to maintain a nominal cover of 40 mm from the inside face of the outer leaf of masonry (Figure 3A.2).

3A.3.10 **A1** Vertical reinforcement in paragraph 3A.3.8 should extend a minimum height of 1.2 metres from the foundation (Figure 3A.2). It may then be continued with reinforcement with an area of not less than 250 mm^2/m (180 mm^2/m for granular soils, Table 3A.4). All reinforcement should be adequately lapped (Table 3A.5).

Table 3A.5 Lap length of bars in infill concrete

Bar diameter (mm)	Lap length (mm)
6	300
8	400
10	500
12	600
16	800

3A.3.11 **A1** Horizontal reinforcement of an area not less than 0.5 x *As* (where *As* is the area of reinforcement given in Tables 3A.2, 3A.3 or 3A.4) should be provided and be effectively continuous for the entire length of the wall, including corners (Figure 3A.3).

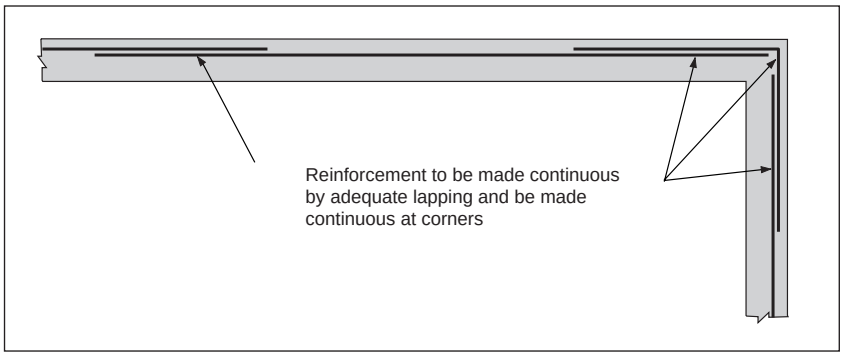


Figure 3A.3 Continuity of horizontal reinforcement in masonry walls

3A.3.12 **A1** Reinforcement may be taken as being effectively continuous where the bars are provided with a lap length as given in Table 3A.5.

3A.3.13 **A1** The size and bar spacing of reinforcement to achieve the cross sectional areas in paragraphs 3A.3.8, 3A.3.10 and 3A.3.11 may be obtained from Table 3A.6.

3A.3.14 **A1** The spacing of reinforcement should not exceed 500 mm.

3A.3.15 **A1** Mortar should be designation (i) or (ii) as given in BS 5628: Part 2: 1995, or 1 : 0 to ¼ : 3 (cement : lime : sand) measured by volume of dry materials.

3A.3.16 **A1** Concrete infill for reinforced masonry walls should consist of proportions by volume of dry materials of 1 : 0 to ¼ : 3 : 2 (cement : lime : sand: 10 mm maximum size aggregate), or be:

(a) An RC30 designated mix to BS 5328: Part 2, except where the provisions of 3A.3.5 are used when it should be:

(b) An RC35 designated mix to BS 5328: Part 2.

3A.3.17 **A1** The slump of the infill mix should be appropriate to the size and configuration of the space to be filled, but should be between 75 mm and 175 mm for unplasticised mixes. In order to ensure that complete filling and compaction is achieved, designers should consider the workability of the infill in relation to the height of pour. For low-lift construction of walls complying with paragraph 3A.2.2, the specified slump should be not less than 75 mm, and with high-lift construction not less than 125 mm.

3A.3.18 **A1** Masonry should be adequate for the prevailing exposure conditions.

3A.3.19 **A1** Where the infill concrete in high-lift grouted masonry construction is used to provide durability protection to the reinforcement, it should contain an expanding agent or other suitable measures should be taken to avoid early-age shrinkage.

Table 3A.6 Cross sectional areas (mm^2/m) of bars for specified spacings

Spacing (mm)	Size				
	6 mm	8 mm	10 mm	12 mm	16 mm
125	226	402	628	904	
150	188	335	523	754	
175	162	287	448	646	
200	141	251	392	565	
225	126	223	349	502	893
250	113	201	314	452	804
275	103	182	285	411	731
300	94	167	261	377	670
325	87	154	241	348	618
350	80	143	224	323	574

APPENDIX 3B - IN-SITU CONCRETE RETAINING WALLS

3B.1 THE USE OF THIS APPENDIX

3B.1.1 **A1** When using this appendix it should be noted that:

(a) It must be used in conjunction with Section 3;

(b) If wall thickness is to be determined according to paragraph 3B.2, all appropriate design conditions given in this appendix must be satisfied;

(c) Walls should comply with the relevant requirements of BS 8110: Part 1: 1997, with the exception of the provisions given in paragraph 3B.3;

(d) The guidance is based upon a characteristic strength of concrete of 35 N/mm^2.

3B.2 THICKNESS OF WALLS

3B.2.1 **A1** General wall thickness and reinforcement may be determined according to this appendix provided:

(a) The conditions relating to the building of which the wall forms a part (paragraph 3.5), and

(b) The conditions relating to the wall (Table 3.1 and paragraphs 3.6 to 3.11.)

are met.

3B.2.2 **A1** For external retaining walls, the thickness of wall should be not less than that required by Tables 3B.1, 3B.2 and 3B.3

3B.3 CONSTRUCTION MATERIALS AND WORKMANSHIP

3B.3.1 **A1** The reinforcement for reinforced in-situ concrete walls should comply with BS 4449.

3B.3.2 **A1** The reinforcement as indicated in paragraph 3B.3.1 should be of carbon steel in buried concrete, concrete continually submerged in fresh water or external concrete. Where the concrete is exposed to sea water or flowing water with a pH less than or equal to 4.5, specialist advice should be obtained.

3B.3.3 **A1** The reinforcement should be adequately supported to maintain a cover of 40 mm both from the outside and inside faces of the in-situ concrete wall (Figure 3B.1).

3B.3.4 **A1** Vertical reinforcement as given in Tables 3B.1, 3B.2 and 3B.3 should be provided in the outside (retained ground) face as shown in Figure 3B.1.

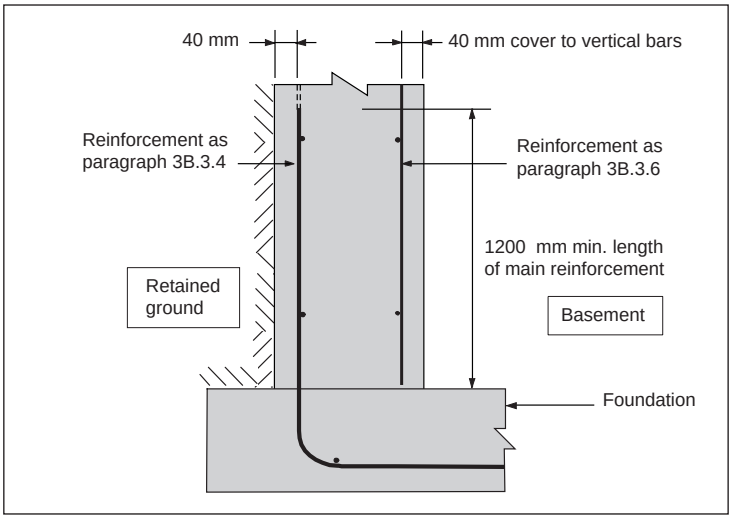


Figure 3B.1 Positioning of reinforcement in in-situ concrete basement retaining wall

Table 3B.1 Minimum reinforcement requirements for propped wall retaining a maximum of 2.7 m of soil

Foundation type	Soil type (well drained)	Vertical load (kN/m) up to	Moment taken as acting at base of wall (kN/m)	Area of reinforcement *As* (mm^2/m)	
				Wall thickness (mm) 200	300
Raft	Clay and granular	70	20	500	390*
		50	15	370	390*
		30	10	260	390*
Strip	Clay	Any	17	420	390*
	Granular		12	290	390*

Table 3B.2 Minimum reinforcement requirements for cantilevered wall (un-propped) retaining a maximum of 2.1 m of soil

Soil type (well drained)	Moment taken as acting at base of wall (kN/m)	Area of reinforcement *As* (mm^2/m)	
		Wall thickness (mm) 200	300
Clay	20	500	390*
Granular	15	370	390*

Table 3B.3 Minimum reinforcement requirements for cantilevered wall (un-propped) retaining a maximum of 1.6 m of soil

Soil type (well drained)	Moment taken as acting at base of wall (kN/m)	Area of reinforcement *As* (mm^2/m)	
		Wall thickness (mm) 200	300
Clay	10	260	390*
Granular	7	260*	390*

* Note to tables 3B.1 to 3B.3: This is minimum reinforcement and provides for a moment capacity of 10 kN/m with a 200 mm wall and 25 kN/m with a 300 mm wall.

3B.3.5 **A1** Vertical reinforcement in paragraph 3B.3.4 should extend a minimum height of 1.2 metres from the foundation (Figure 3B.1). It may then be continued with reinforcement of area not less than 375 mm^2/m in 300 mm thick walls, and 250 mm^2/m in 200 mm thick walls. All reinforcement should be adequately lapped.

3B 3.6 **A1** Reinforcement should be provided in the inside face (basement face) with an area not less than 390 mm^2/m in 300 mm thick walls, and 260 mm^2/m in 200 mm thick walls (Figure 3B.1).

3B.3.7 **A1** Horizontal reinforcement of an area not less than 375 mm^2/m in 300 mm thick walls, and 250 mm^2/m in 200 mm thick walls should be provided in each face and be effectively continuous for the entire length of the wall, including corners (Figure 3B.2).

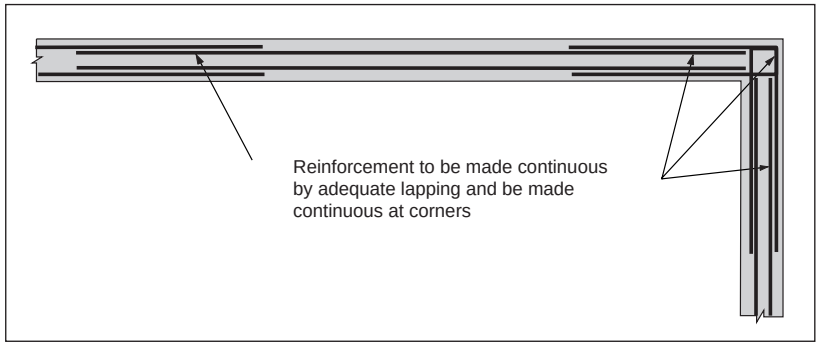


Figure 3B.2 Continuity of horizontal reinforcement in in-situ concrete walls

3B.3.8 **A1** Where the wall has a thickness greater than 300 mm, the minimum area of steel (mm^2/m) given in paragraphs 3B.3.6 and 3B.3.7 should be numerically not less than 1.3 and 1.25 times the wall's thickness (mm) respectively.

3B.3.9 **A1** Reinforcement may be taken as being effectively continuous or adequately lapped where the bars are provided with a lap length of 500 mm.

3B.3.10 **A1** The size and bar spacing of reinforcement to achieve the cross sectional areas in paragraphs 3B.3.4 to 3B.3.7 may be obtained from Table 3A.6.

3B.3.11 **A1** The spacing of reinforcement should not exceed 750 mm.

3B.3.12 **A1** The concrete in non-aggressive soil conditions should be not less than a RC35 to BS 5328: Part 2. In aggressive soil conditions the guidance in BS 5328: Part 1 should be followed.

3B.3.13 **A1** The specified slump of the concrete should be sufficient to enable proper placing and compaction of the mix, and should generally be not less than 75 mm.

APPENDIX 3C - FOUNDATIONS OF PLAIN AND REINFORCED CONCRETE

3C.1 CONDITIONS RELATING TO THE SUB-SOIL

3C.1.1 **A1** There should not be:

(a) Made-up ground or a wide variation in type of soil within the loaded area; nor

(b) A weaker type soil at such a depth below the soil on which the foundation rests as could impair the stability of the structure.

3C.2 DESIGN PROVISIONS

3C.2.1 **A1** The provisions of Approved Document A, paragraph 1E2, may be applied to foundations in a building containing a basement except in the case of retaining walls, where the provisions should be modified as follows:

(a) Strip foundations under walls which carry vertical loads and/or lateral earth loads should have the minimum widths and be positioned eccentrically to the wall as given in paragraph 3C.3.1;

(b) Raft foundations as covered by this appendix should extend beyond the centreline of the external wall for a distance equal to 2T, where T is the thickness of the foundation, and be continuous and of the same thickness over the whole area of the basement;

(c) For reinforced foundations in chemically aggressive soil conditions, guidance in BS 5328: Part 1 should be followed. But, as with non-aggressive conditions, the concrete should be of a strength not less than Grade 35 to BS 5328: Part 2;

(d) The minimum thickness of a concrete strip foundation or a raft foundation should be 200 mm;

(e) The minimum area of steel (mm^2/m) given in paragraphs 3C.4.1 and 3C.5.1 to 3C.5.3 should be numerically not less than 1.3 times the foundation thickness (mm) for foundations having a thickness more than 200 mm.

(f) A concrete blinding should normally be provided to ensure adequate support to the bar spacers.

3C.2.2 The foundations in a dwelling having a basement under only part of the plan area of the dwelling should be designed and positioned so as to:

(a) Prevent lateral forces from the soil pressure bulb beneath the foundations being applied to the basement retaining walls; and

(b) Prevent unacceptable differential settlement due to the use of foundations varying in depth.

3C.2.3 The provisions of paragraph 3C.2.2 may be taken as being met where:

(a) The angle between the leading edge of any two adjacent foundations is not more than 45^0 (Figure 3C.1); and

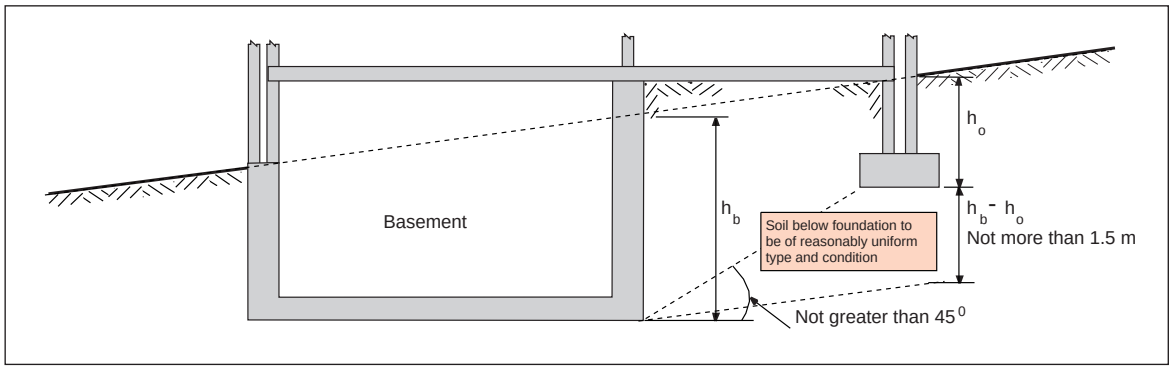


Figure 3C.1 Positioning foundations to prevent load transfer to walls and to minimise differential settlement

(b) The difference in the depth between any foundations within the plan area of the dwelling does not exceed 1.5 m (Figure 3C.1) as measured on a plane parallel to the surface of the ground; and

(c) The soil below the foundations over the plan area of the dwelling is of a reasonably uniform type and condition (Table 3C.1).

3C.3 MINIMUM WIDTH AND POSITIONING OF STRIP FOUNDATIONS SUPPORTING A RETAINING WALL

3C.3.1 **A1** Provided that the previous conditions relating to the subsoil (paragraph 3C.1) and design provisions relating to the foundations (paragraph 3C.2) are observed, and the type and condition of subsoil are known, and loading at the base of the wall is within acceptable limits, the recommended widths of foundations (a+b) given in Table 3C.1 may be used and positioned under the retaining wall as shown in Figure 3C.2.

Table 3C.1 Minimum foundation widths and wall positions for differing ground conditions

Type	Condition	Moment	Minimum foundation widths and wall positions									
			Total load of load-bearing wall within (kN/linear metre)									
			Up to 30		31 to 40		41 to 50		51 to 60		61 to 70	
			a	b	a	b	a	b	a	b	a	b
I Rock		5	200	525	200	475	200	400	200	375	200	350
		10	200	725	200	625	200	550	200	500	200	475
		15	200	875	200	750	200	725	200	625	200	575
		20	200	1050	200	900	200	825	200	725	200	675
		25	200	1225	200	1025	200	875	200	800	200	725
II Gravel, sand	Dense	5	200	550	200	475	200	400	250	425	300	425
		10	200	775	150	675	200	575	250	550	300	550
III Clay Sandy clay	Stiff	15	200	925	160	850	200	750	250	650	300	650
		20	200	1100	200	950	200	875	250	775	300	750
		25	200	1275	200	1050	200	950	250	850	300	800
IV Clay Sandy clay	Firm	5	200	575	200	475	200	425	300	500	300	500
		10	200	800	200	725	200	625	300	625	300	625
		15	200	1000	200	900	200	800	300	725	300	725
		20	200	1150	235	1025	200	925	300	825	300	825
		25	200	1325	235	1125	200	1050	300	900	300	900
V Sand Silty sand Clayey sand	Loose	5	200	575								
		10	200	800								
		15	200	1050								
		20	200	1200								
		25	200	1375								
VI Silt Clay Sandy clay Silty clay	Soft	5	200	600								
		10	200	850								
		15	200	1075								
		20	200	1275								
		25	200	1450								
VII Silt Clay Sandy clay Silty Clay	Very soft	5	200	600								
		10	200	950								
		15	200	1200								
		20	200	1400								
		25	200	1600								

Note:
In relation to subsoil types V, VI and VII foundations do not fall within the provisions of this section if the total load exceeds 30 kN/m

3C.4 MINIMUM REINFORCEMENT FOR REINFORCED STRIP FOUNDATIONS SUPPORTING A RETAINING WALL

3C.4.1 **A1** Provided that the previous conditions relating to the subsoil and foundations (paragraph 3C.3) are observed, the minimum reinforcement given in Tables 3A.2, 3A.3 and 3A.4 or Tables 3B.1, 3B.2 and 3B.3 (but based on the thickness of the floor rather than the thickness of the in-situ wall), as appropriate, should be used and positioned in the foundations with a cover of 40 mm as shown in Figure 3C.2.

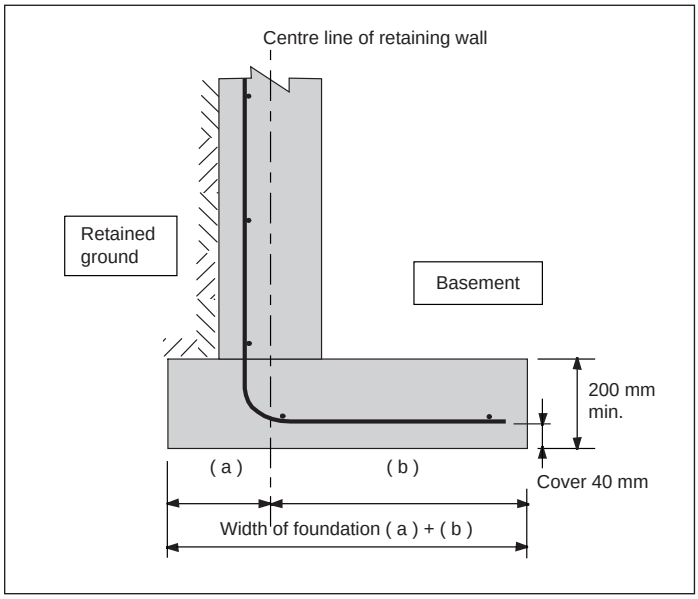


Figure 3C.2 Foundation requirements for strip foundation

3C.5 MINIMUM REINFORCEMENT FOR REINFORCED RAFT FOUNDATIONS SUPPORTING A RETAINING WALL

3C.5.1 **A1** Provided that the previous conditions relating to the subsoil and foundations (paragraph 3C.3) are observed, the minimum reinforcement given in Tables 3A.2, 3A.3 and 3A.4 or Tables 3B.1, 3B.2 and 3B.3, as appropriate, should be used and positioned with a cover of 40 mm in the foundations as shown in Figure 3C.3.

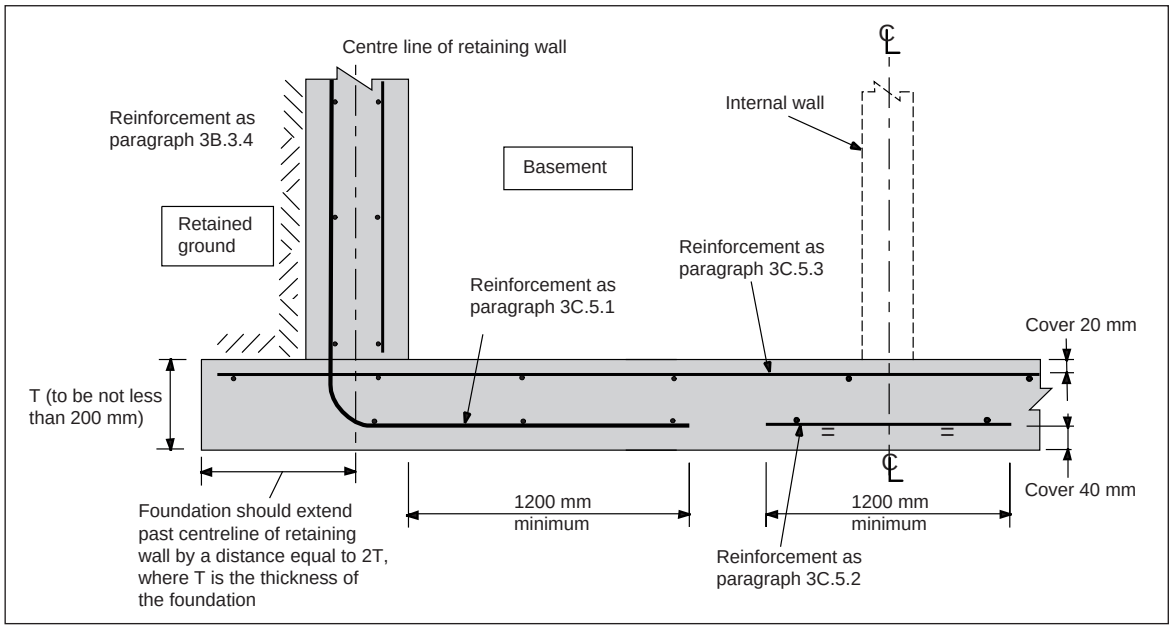


Figure 3C.3 Reinforcement in raft foundation

3C.5.2 **A1** Where a raft foundation supports an internal loadbearing wall, reinforcement as given in Table 3C.2 should be positioned in the bottom of the foundation to provide a cover of 40 mm as shown in Figure 3C.3.

3C.5.3 **A1** In addition to the continuation of the wall reinforcement into the foundation as in paragraph 3C.5.1, reinforcement as given in Table 3C.3 should be provided in the top of the foundation slab as shown in Figure 3C.3 and have a cover of 20 mm. This reinforcement is to cater for loads transferred to the foundation as a result of soil/structure interaction and should be provided over the whole area of the foundation. It does not allow for the effects of pressures caused by a water table standing above the underside of the raft foundation. This case is outside the limitations of this appendix and reference should be made to paragraph 3.1.2 and Appendix 3D.

Table 3C.2 Bottom reinforcement under internal loadbearing walls on a raft foundation

<table>
<tr><th rowspan="3" colspan="2">Type of subsoil (and condition)</th><th colspan="6">Reinforcement requirements</th></tr>
<tr><th colspan="6">Total load of load-bearing walling not more than (kN/linear metre)</th></tr>
<tr><th>20</th><th>30</th><th>40</th><th>50</th><th>60</th><th>70</th></tr>
<tr><td>I</td><td>Rock</td><td>A252 #</td><td>A252 #</td><td>A252 #</td><td>A252 #</td><td>A252 #</td><td>A252 #</td></tr>
<tr><td>II</td><td>Gravel, sand (Dense)</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="2"></td><td>A252</td><td>A252 + 8 @ 400</td><td>A252 + 8 @ 400</td></tr>
<tr><td>III</td><td>Clay, sandy clay (Stiff)</td><td>A252 + 8 @ 400</td><td>A252 + 8 @ 400</td><td rowspan="2"></td><td>A252 + 8 @ 200</td></tr>
<tr><td>IV</td><td>Clay, sandy clay (Firm)</td><td rowspan="4">A252</td><td rowspan="3">A252</td><td rowspan="2"></td><td rowspan="2"></td><td>A252 + 8 @ 200</td><td>A252 + 10 @ 200</td></tr>
<tr><td>V</td><td>Sand, silty clay, clayey sand (Loose)</td><td colspan="4" rowspan="3">Note:
In relation to types V, VI and VII, foundations do not fall within the provisions of this section if the total load exceeds 30 kN/m.</td></tr>
<tr><td>VI</td><td>Silt, clay, sandy clay, silty clay (Soft)</td><td rowspan="2">A252 + 8 @ 400</td></tr>
<tr><td>VII</td><td>silt, clay, sandy clay, silty clay (Very soft)</td></tr>
<tr><td colspan="8">Notes:
1. Reinforcement where prefixed by the letter ‘A’ refers to steel fabric to BS 4483.
2. Reinforcement where prefixed by the letter ‘A’ and followed by +, refers to steel fabric to BS 4483 plus high yield bars of the indicated diameter (mm) and spacing (mm), transverse to the wall.
3. The reinforcement given may be replaced by other bars of equivalent strength.
4. Where shown #, reinforcement may be omitted where waterproofing system does not require a concrete having a controlled crack width.</td></tr>
</table>

Table 3C.3 Top reinforcement in raft foundation

Type of subsoil (and condition)		Moment	Reinforcement requirements					
			Total load of load-bearing walling not more than (kN/linear metre)					
			20	30	40	50	60	70
I	Rock	Any	A252	A252	A252	A252	A252	A252
II	Gravel Sand (Dense)	0 5 10 15 20	A252	A252	A252	A252	A252	A252
III	Clay Sandy clay (Stiff)	0 5 10 15 20	A252	A252	A252	A252	A393 A252	A393 A252
IV	Clay Sandy clay (Firm)	0 5 10 15 20	A252	A252	A393 A252	A393 A252	10 @ 175 A393	10 @ 150 10 @ 175 A393
V	Sand Silty sand Clayey sand (Loose)	0 5 10 15 20	A252	A252	Note: In relation to types V, VI and VII, foundations do not fall within the provisions of this section if the total load exceeds 30 kN/m.			
VI	Silt Clay Sandy clay Silty clay (Soft)	0 5 10 15 20	A252	A252				
VII	Silt Clay Sandy clay Silty clay (Very soft)	0 5 10 15 20	A252	A393 A252				

Notes:
1. Reinforcement prefixed by the letter 'A' refers to steel fabric to BS 4483. Where 'A' is not used, the bar diameter (mm) and spacing (mm) in both of two directions is given.
2. Where the condition of a gravel/sand subsoil (Type II/V) is determined as medium by a soil investigation, it may be treated as Stiff Type III subsoil.
3. Where the minimum thickness of the foundation is greater than 200 mm the area of reinforcement (mm^2/m) should be numerically not less than 1.3 times the foundation thickness.

APPENDIX 3D - CODES, STANDARDS AND REFERENCES FOR REQUIREMENTS A1 AND A2

3D.1 INTRODUCTION

3D.1.1 **A1** This appendix is relevant to all dwellings, and lists codes, standards and other references for structural design and construction.

3D.2 DESIGN INFORMATION AND REFERENCES

3D.2.1 **A1** Loading - general: dead and imposed, imposed roof loads and wind loads should be in accordance with paragraph 4.2 of Approved Document A.

3D.2.2 **A1** Loading - earth loads: nominal earth loads should be obtained in accordance with normal practice taking into account:

(a) The water table;

(b) Surcharge loading;

(c) The effect of any propping or buttressing of the retaining wall.

Earth pressures at rest should be used in the situation where lateral movement of the top of a retaining wall is effectively restricted, for example as would be the case with most propped cantilevers.

3D.2.3 **A1** Structural work of masonry can be in accordance with paragraph 4.4 of Approved Document A, and can include BS 5628: *Code of practice for use of masonry*: Part 1: 1992 *Structural use of unreinforced masonry*, BS 5628: Part 2: 1995 *Structural use of reinforced and prestressed masonry*, and BS 5628: Part 3: 1985 *Materials and components, design and workmanship*.

3D.2.4 **A1** Structural work of reinforced, prestressed or plain concrete.
BS 8110: *Structural use of concrete*:
Part 1: 1997 *Code of practice for design and construction*.
Part 2: 1985 *Code of practice for special circumstances*.
Part 3: 1985 *Design charts for singly reinforced beams, doubly reinforced beams and rectangular columns*.
BS 8007: 1987 *Code of practice for design of concrete structures for retaining aqueous liquids*.

3D.2.5 **A1** Foundations can be in accordance with: BS 8004: 1986 *Code of practice for foundations*.

3D.3 GROUND MOVEMENT (REQUIREMENT A2B)

3D.3.1 **A2** The guidance given in paragraph 4.9 of Approved Document A; Ground Movement (Requirement A2b), should also be applied to buildings containing a basement.

4 FIRE SAFETY

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part B of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document B should also be followed or the requirements should be met in some other way.

REQUIREMENT	LIMITS ON APPLICATION
B1 MEANS OF ESCAPE The building shall be designed and constructed so that there are means of escape in case of fire from the building to a place of safety outside the building capable of being safely and effectively used at all material times.	Requirement B1 does not apply to any prison provided under section 33 of The Prisons Act 1952 (power to provide prisons etc.).
B2 INTERNAL FIRE SPREAD (LININGS) (1) To inhibit the spread of fire within the building, the internal linings shall - (a) resist the spread of flame over their surfaces; and (b) have, if ignited, a rate of heat release which is reasonable in the circumstances. (2) In this paragraph 'internal linings' mean the materials lining any partition, wall, ceiling or other internal structure.	
B3 INTERNAL FIRE SPREAD (STRUCTURE) (1) The building shall be designed and constructed so that, in the event of fire, its stability will be maintained for a reasonable period. (2) A wall common to two or more buildings shall be designed and constructed so that it resists the spread of fire between those buildings. For the purpose of this sub-paragraph a house in a terrace and a semi-detached house are each to be treated as a separate building. (3) To inhibit the spread of fire within the building, it shall be sub-divided with fire-resisting construction to an extent appropriate to the size and intended use of the building. (4) The building shall be designed and constructed so that the unseen spread of fire and smoke within concealed spaces in its structure and fabric is inhibited.	Requirement B3(3) does not apply to material alterations to any prison provided under section 33 of the Prisons Act 1952.
B4 EXTERNAL FIRE SPREAD (1) The external walls of the building shall resist the spread of fire over the walls from one building to another, having regard to the height, use and position of the building. (2) The roof of the building shall resist the spread of fire over the roof and from one building to another, having regard to the use and position of the building.	
B5 ACCESS AND FACILITIES FOR THE FIRE SERVICE (1) The building shall be designed and constructed so as to provide facilities to assist fire fighters in the protection of life. (2) Provision shall be made within the site of the building to enable fire appliances to gain access to the building.	

4.1 MEANS OF ESCAPE

4.1.1 **B1** The provisions of the paragraphs under 'Analysis of the problem' and 'Criteria for means of escape' within the Guidance section of Approved Document B should be followed.

4.1.2 **B1** In a dwelling house with no storey having a floor more than 4.5 metres above external ground level, the basement need not be separated from the rest of the house (Figure 4.1).

4.1.3 **B1** When the basement storey is not separated, rooms on the ground and upper storeys effectively become inner rooms and are subject to the provisions of Approved Document B.

4.1.4 **B1** In a dwelling house with one or more storeys having a floor which is more than 4.5 metres above external ground level, the basement should be separated from the ground and upper storeys and the provisions described in Approved Document B, under 'Additional provisions for houses with a floor more than 4.5 metres above ground level' should be followed (Figure 4.1).

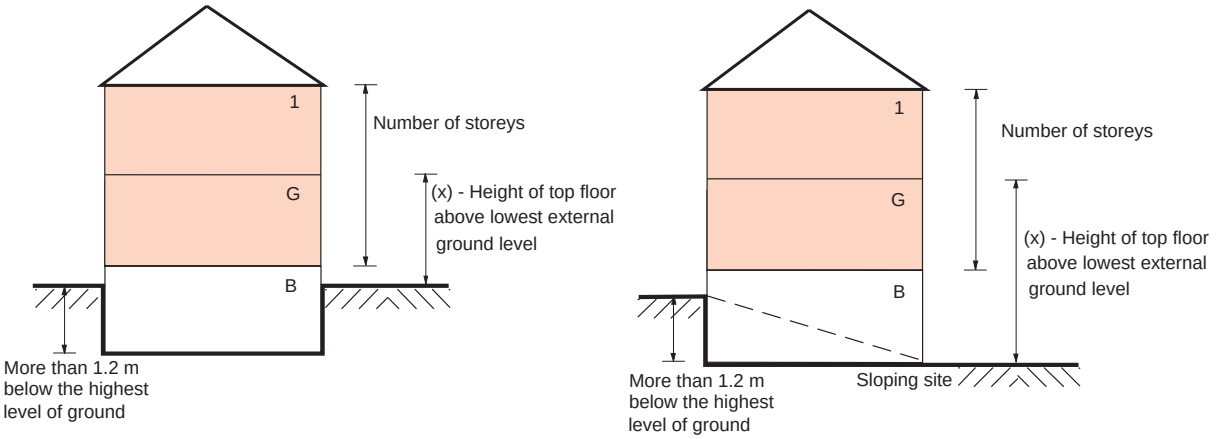
4.1.5 **B1** In a block of flats or maisonettes, the basement storey should be separated from the ground and upper storeys unless the basement storey is constructed to enable direct access only from a single ground floor flat or maisonette (Figure 4.2).

4.1.6 **B1** In houses or flats where the basement storey is separated, any vertical duct (eg for ventilation) which passes through the separation and the upper storeys should have the same fire resistance as the separating construction.

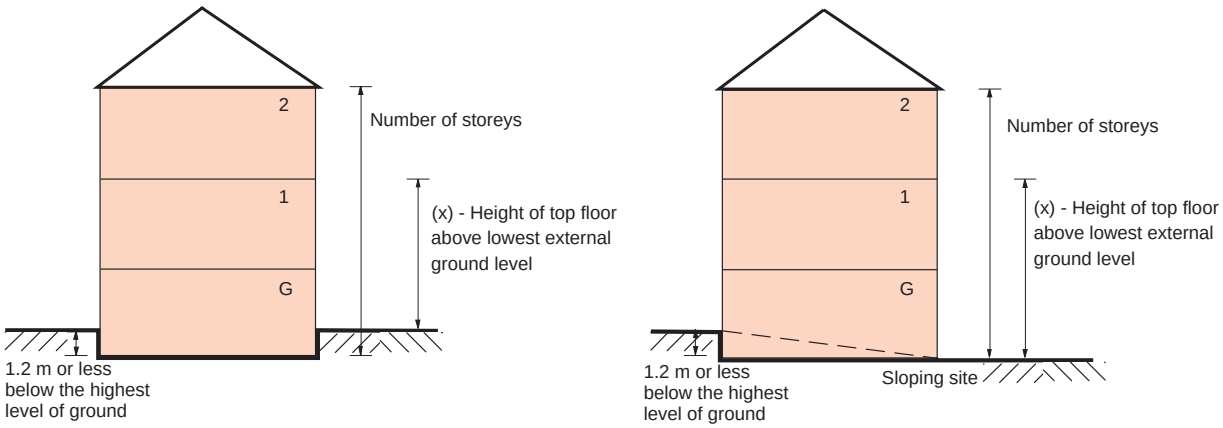
Notes to 4.1

1. The definition of a basement storey in Approved Document B is 'A storey with a floor which at some point is more than 1.2 metres below the highest level of ground adjacent to the outside walls'. (However, see 'Application of fire resistance standards' in Table A.2 in Approved Document B, for situations where the storey is considered to be a basement only because of a sloping site.) The basement storey is therefore not counted when assessing the total number of storeys for purposes of fire resistance or means of escape when the basement floor level is more than 1.2 metres below the highest external ground level. When it is less than 1.2 metres, the basement storey is included in the number of storeys in the building (Figure 4.1).

2. 'Separated' means where the basement is separated from the remainder of the building by fire-resisting construction (see Approved Document B). To maintain this separation, measures should be taken to prevent fire and smoke in the basement from entering the stairway. This may be achieved by providing a self-closing fire door set in fire-resisting construction at either the top or bottom of the basement access stair.



(a) When the basement floor is **more** than 1.2 metres below the highest ground level adjacent to the outside walls, the basement storey is **not** included in the number of storeys.



(b) When the basement floor is 1.2 metres or **less** below the highest level of ground adjacent to the outside walls, the basement storey **is** included in the number of storeys.

In both cases (a) and (b) the elements of structure should -

When the number of storeys is 2 and where (X) is not more than 5 metres, have 30 minutes fire resistance (modified 30 minutes for the upper floor except for floors over the garage).

When the number of storeys is 3, have 30 minutes fire resistance.

When the number of storeys is 4 or more, have 60 minutes fire resistance.

If (X) is not more than 4.5 metres, the basement need not be separated from the rest of the building but escape windows or doors should be provided to all habitable rooms.

If (X) is more than 4.5 metres, the basement should be separated and the provisions included in paragraphs 1.20, 1.21 and 1.22 of Approved Document B should be followed.

Figure 4.1 Requirements for fire resistance and provisions for means of escape in dwellings containing a basement

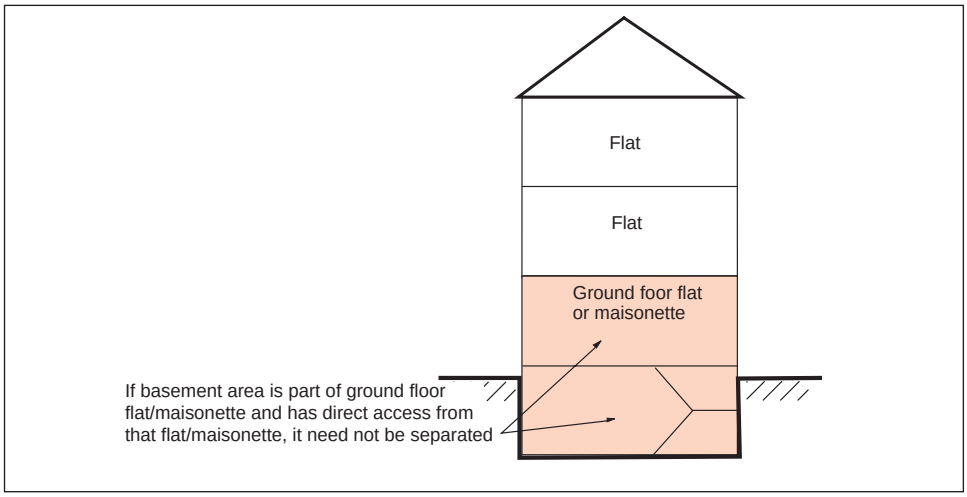


Figure 4.2 Ground floor flat or maisonette with direct access to its own basement

4.2 INNER ROOMS

4.2.1 **B1** A basement room whose only escape route is through another room at basement or upper floor level is termed an inner room and is at risk from a fire in the outer room (access room). This situation may arise in open plan layouts. Such an arrangement is acceptable only when the inner room (Figure 4.3) is:

(a) a kitchen
(b) a laundry or utility room
(c) a dressing room
(d) a bathroom, wc, or shower room, or
(e) any other room in the basement which has an openable window or external door suitable for rescue and which complies with paragraph 4.4.

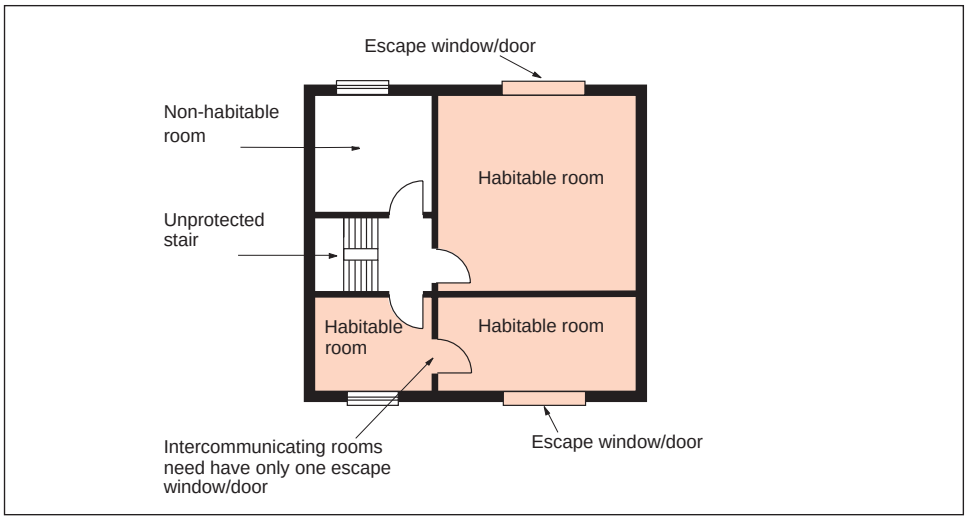


Figure 4.3 Provision of escape from rooms in a basement storey which is not separated from the rest of the house.

4.2.2 **B1** If the basement is not separated from the rest of the house, the basement rooms are effectively inner rooms and are subject to the provisions described in paragraph 4.2.1.

4.3 ALTERNATIVE ESCAPE ROUTES

4.3.1 **B1** Because combustion products tend to rise, there is danger that people escaping from a fire in a basement would find that they had to move into a layer of smoke if they had to use an internal stair. Therefore, if a basement which is separated from the rest of the house contains a bedroom, it should be provided with an alternative escape route via a door or window complying with paragraph 4.4.

4.4 WINDOWS AND EXTERNAL DOORS FOR ESCAPE

4.4.1 **B1** Any window or external door provided for escape purposes from the basement storey should comply with the following conditions.

(a) It should have an unobstructed opening that is at least 850 mm by 500 mm. The bottom of the opening should be not more than 1100 mm above the internal floor level (Figure 4.4a).

(b) The threshold height of an external door should not be more than 150 mm above the adjacent external ground level, or a suitable ramp, step or steps should be provided (Figure 4.4b).

(c) It should enable the person escaping to reach a place free from danger from fire. This is a matter for judgement in each case but in general the depth of a courtyard or back garden, from which there is no exit other than through other buildings, needs to exceed the height of the dwelling (Figure 4.5). It also means that when a safety barrier is provided around a lightwell to an escape window, the barrier should incorporate a gate or opening to allow exit.

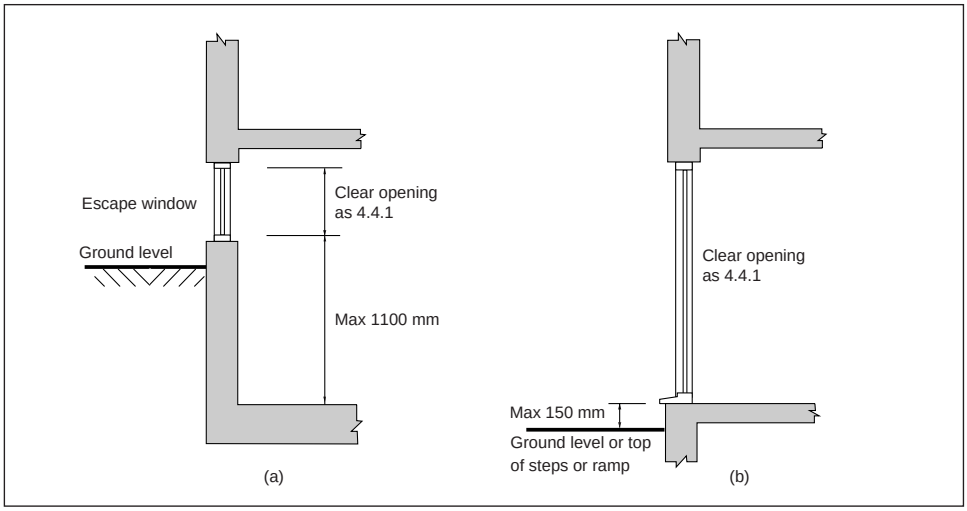


Figure 4.4 Position and size of escape windows and doors suitable for escape or rescue purposes from a room in a basement

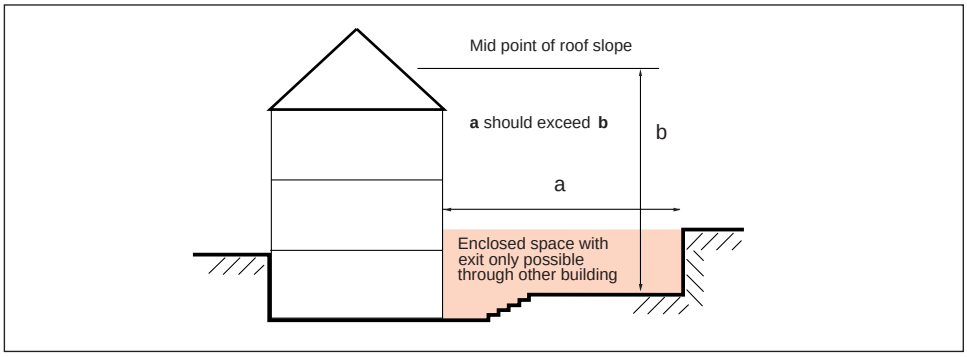


Figure 4.5 Conditions for it to be acceptable for a basement storey exit to lead into an enclosed space

4.4.2 **B1** A window provided for escape from a room at ground or upper floor storeys should follow the provisions for 'Escape windows' in Approved Document B.

4.5 SMOKE ALARMS

4.5.1 **B1** Smoke alarms should be provided in the basement area. The provisions for dwellings described in Approved Document B should be followed.

4.6 STAIRWAYS

4.6.1 **B1** Stairways serving the basement storey should meet the requirements of Part K of the Regulations.

4.6.2 **B1** Because of their situation, basement stairs are more likely to be filled with smoke and heat than stairs in ground or upper storeys. Special measures are therefore needed in order to prevent a basement fire endangering upper storeys. These are set out in the following paragraphs.

(a) If a common stair in a block of flats forms part of the only escape route from a dwelling, it should not be continued down to serve the basement storey. The basement should be served by a separate stair with a separate final exit (Figure 4.6).

(b) If there is more than one common stair in a block of flats with intercommunication between them at each upper floor level, one stair must terminate at ground floor level. The other stair(s) may connect to the basement storey providing there is a ventilated protected lobby (or corridor) between the stair and the accommodation at basement level (Figure 4.7).

(c) Where a common stair in a block of flats forms part of the only escape route from a dwelling, it should not also serve any covered car park, boiler room, fuel storage space or other ancillary accommodation of similar fire risk.

(d) Any common stair in a block of flats which does not form part of the only escape route from a dwelling may also serve ancillary accommodation if it is separated from the ancillary accommodation by a ventilated and protected lobby.

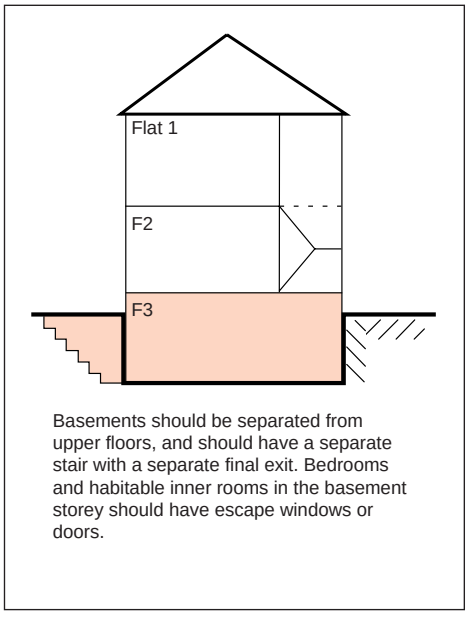


Figure 4.6 Flats with one common stair

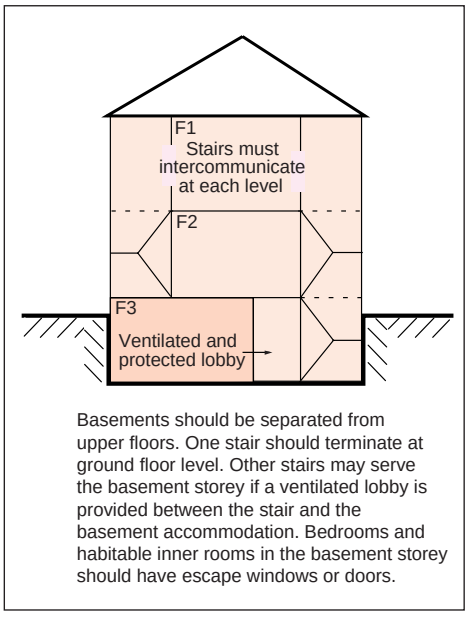


Figure 4.7 Flats with more than one common stair

4.7 PERIODS OF FIRE RESISTANCE

4.7.1 **B3** The period of fire resistance to be achieved for elements of structure in houses and flats incorporating basements should follow the provisions of Approved Document B. The periods of fire resistance for basements are shown in Table 4.1. All loadbearing elements of structure in the basement storey must have at least the same fire resistance as the loadbearing elements of structure at ground and upper floor levels.

Table 4.1 Minimum periods of fire resistance for a basement not more than 10 m deep below ground

Purpose group of building	Minimum period (minutes) for elements of structure in a basement storey[1]
Dwelling house	30[2]
Flats and maisonettes	60

Notes:
1. The floor over a basement should meet the provisions for the ground and upper storeys if that period is higher.
2. Increased to a minimum of 60 minutes for compartment walls and floors, and where the depth of basement exceeds 10 m.

4.8 CONSTRUCTION OF COMMON STAIRS

4.8.1 **B1** Every escape stair and its associated landings from the basement of a block of flats or maisonettes should be constructed of materials of limited combustibility. (This does not apply to a private stair in a maisonette.) But the upper tread surface may be of combustible material unless it is a firefighting staircase or landing (see Approved Document B).

4.9 FIRE RESISTING DOORS

4.9.1 **B1** Fire doors should have the appropriate performance as set out in Table 4.2. Doors are identified by their performance under test to BS 476: Part 22, in terms of integrity for a period of minutes, eg FD 30. A suffix (S) is added for doors where smoke leakage at ambient temperatures should be restricted. The method of test exposure is from each side of the door separately, except in the case of lift doors which are tested from the landing side only.

4.9.2 **B1** All fire doors must be fitted with an automatic self-closing device except for fire doors to cupboards and service ducts which are normally kept locked shut.

Table 4.2 Provision of fire doors

Position of door	Minimum fire resistance of door in terms of integrity (minutes)[1]
In a compartment wall separating a basement flat or maisonette from a space in common use	FD 30S
In a compartment wall separating a basement area from a space in common use	FD 30S
Any door forming part of the separation between a basement and the ground and upper storeys in a single family dwelling house with an upper storey more than 4.5 metres above ground level	FD 20
Any door forming part of the separation at basement level between a ventilated lobby and a staircase serving the basement and upper floors in a block of flats	FD 30S
Any door between a garage and the basement area of a dwelling house	FD 30

Note 1: To BS 476: Part 22 (or BS 476: Part 8) subject to the provisions of paragraph 4.9.1

4.10 MECHANICAL VENTILATION OF COMMUNAL CAR PARKING AREAS

4.10.1 **B3** Communal car parking areas in basements which do not have 'Natural ventilation' in accordance with Approved Document B should be provided with 'Mechanical ventilation' following the provisions of Approved Document B.

5 CONSERVATION OF FUEL AND POWER

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part L of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document L should also be followed or the requirements should be met in some other way.

REQUIREMENT	LIMITS ON APPLICATION
L1 CONSERVATION OF FUEL AND POWER Reasonable provision shall be made for the conservation of fuel and power in buildings by –	
(a) limiting the heat loss through the fabric of the building;	Requirement L1(a), (b), (c) and (d) apply only to – (a) dwellings (b) other buildings whose floor area exceeds 30 m^2.
(b) controlling the operation of the space heating and hot water systems;	
(c) limiting the heat loss from hot water vessels and hot water pipework;	
(d) limiting the heat loss from hot water pipes and hot air ducts used for space heating;	
(e) installing in buildings artificial lighting systems which are designed and constructed to use no more fuel and power than is reasonable in the circumstances and making reasonable provision for controlling such systems.	Requirement L1(e) applies only within buildings where more than 100 m^2 of floor area is to be provided with artificial lighting and does not apply to dwellings.

5.1 GENERAL

5.1.1 **L1** The provisions in respect of thermal insulation which are set out in Approved Document L or provisions to an equivalent standard of performance should be applied to dwellings incorporating basements except where noted otherwise in this section.

5.1.2 **L1** Guidance on avoiding technical risks which might arise from the application of energy conservation measures is given in the publications referred to in paragraph 0.7 of Approved Document L.

5.1.3 **L1** Heat transfer through floors and walls of basements is influenced by the ground surrounding the basement structure which acts as a buffer between the internal environment and the external air. The heat flow pattern in basements is complex due to spatial variations and three dimensional and time-dependent aspects. For the purpose of complying with Building Regulations, it is sufficient to use steady state conditions averaged over the basement and expressed as a U-value to provide an adequate approximation of heat loss from basements.

5.1.4 **L1** The satisfactory limitation of heat loss from a building including the basement can be demonstrated for Building Regulation purposes by using one of the three methods described in Approved Document L. These are:

(a) An Elemental method

(b) A Target U-value method (not suitable for applications to buildings being extended)

(c) An Energy Rating method

5.1.5 **L1** Basement retaining walls should be considered as exposed walls and the basement floor as an exposed floor for the purpose of determining the standard U-values when using the Elemental method or for determining the total exposed surface area when using the Target U-value method. Any roof to a basement should meet the provisions for roofs in Approved Document L.

5.1.6 **L1** Any windows and any roof lights in external elements should be included in the allowance for windows given in Approved Document L.

5.1.7 **L1** U-values are obtained separately for basement floors and walls. The U-value of a floor depends on the ratio of the floor perimeter to its area, on the properties of the materials used in the floor and on the depth of the basement floor below ground level. The U-value of a wall depends on the depth of the basement and on the properties of the materials used in the wall.

5.1.8 **L1** The requirements for the construction elements may be obtained separately for each depth of wall or floor.

5.1.9 **L1** Alternatively the requirements for the wall or floor construction elements may be obtained for the average depth calculated using the method in paragraph 5.1.10.

5.1.10 **L1** The average depth of the basement (*Ha*), taking account of the perimeter ground levels and openings for windows and doors where applicable, may be determined from the following equation:

$$\text{Average depth, } H_a = \frac{A_c}{P}$$

Where:

A_c is the total area of the basement walls in square metres in contact with the ground measured on the internal face of the external walls (Figure 5.1).

P is the perimeter of the basement floor in metres measured on the internal face of the external walls.

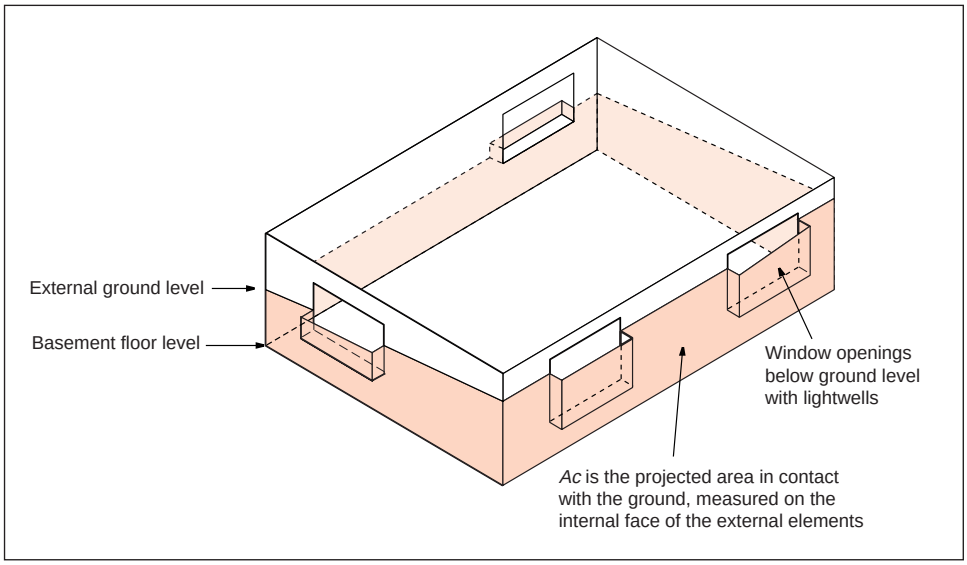


Figure 5.1 Calculating the average basement depth

5.2 ELEMENTAL METHOD

5.2.1 **L1** A way of showing compliance with the requirement would be to show that the thermal performances of the construction elements, taking basement walls and floors as exposed elements (paragraph 5.1.5), conform with the standard U-values given in Table 1 in Approved Document L (column (a) or (b) depending upon the SAP rating on completion).

5.2.2 **L1** One way of achieving the U-values in Table 1 of Approved Document L for the basement construction elements, is to provide continuous insulation of an appropriate thickness estimated from tables in Appendix 5A. Where the insulation is bridged, for example by battens, the thickness should be determined by using a proportional area calculation (such as that described in Approved Document L). Alternative procedures for determining satisfactory provisions for floors and walls of basements are given in Appendix 5B.

5.3 TARGET U-VALUE METHOD

5.3.1 **L1** This method allows higher U-values for some parts of the fabric (ie, higher than those specified in the Elemental method) to be compensated for by lower U-values elsewhere. When using this method it is acceptable for higher or lower U-values in the basement storey to be compensated for in the structure above basement level, provided that the basement and upper levels are within the same dwelling.

5.3.2 **L1** The requirement may be met if the procedures given in Approved Document L under the Target U-value method are complied with, and where the elements of the basement are taken as being exposed (paragraph 5.1.5).

5.3.3 **L1** A method for estimating the U-value of basement construction elements is given in Appendix 5B, which also provides a simplified method for estimating the amount of insulation needed to obtain a specified U-value.

5.4 ENERGY RATING METHOD

5.4.1 **L1** The Energy Rating for the dwelling including the basement should be calculated using the Standard Assessment Procedure extant at the time of notifying the building works. The U-values of the basement construction elements for use in SAP calculations may be determined from paragraph 5.2.2

5.4.2 **L1** When using the SAP, adjustments should be made to the following:

1. **Overall dwelling dimensions** - to be determined with the basement floor being taken as the ground floor in the case of a sloping site or as an 'other floor' when the basement floor is wholly below ground.
2. **Ventilation rate**, 'structural infiltration' - one of the optional values (timber frame or masonry) should be adopted, dependent on the construction of the dwelling excluding the basement.
3. **Heat losses and heat loss parameter**, 'ELEMENT' - the basement floor should be taken as the ground floor. Where there are more than two wall and roof types, calculations can be undertaken on a separate sheet and the sub-total entered under 'other' category in box 35.
6. **Solar gains** - any windows in the basement should be entered according to their orientation. Where this is not known it should be entered as E/W.

Note to 5.4
Clarification of some of the issues concerned with the specification of the input to the SAP calculations is given in BRECSU's publication: *The Goverment's Standard Assessment Procedure for energy rating of dwellings - Conventions for SAP home energy rating - assessors' instructions.*

APPENDIX 5A - TABLES FOR DETERMINING THE THICKNESS OF INSULATION TO ACHIEVE GIVEN U-VALUES

Table 5A.1 Base thickness of insulation layer

	Average depth of basement (m)	Design U-value (W/m^2K)	Thermal conductivity of insulant (W/mK)						
			0.02	0.025	0.03	0.035	0.04	0.045	0.05
			Base thickness of insulating material (mm)						
	AA	A	B	C	D	E	F	G	H
1	0.0	0.30	63	79	95	110	126	142	158
2	0.5		55	68	82	96	109	123	137
3	1.0		49	62	74	86	99	111	124
4	1.5		44	56	67	78	89	100	111
5	2.0		40	50	59	69	79	89	99
6	2.5		35	44	53	62	71	80	89
7	0.0	0.35	54	67	80	94	107	120	134
8	0.5		46	57	68	80	91	103	114
9	1.0		40	51	61	71	81	91	101
10	1.5		34	43	51	60	68	77	85
11	2.0		28	35	42	49	56	63	71
12	2.5		24	30	36	42	48	54	61
13	0.0	0.40	46	58	70	81	93	104	116
14	0.5		39	49	58	68	78	87	97
15	1.0		34	42	50	59	67	76	84
16	1.5		29	36	44	51	58	65	73
17	2.0		25	31	37	43	49	55	62
18	2.5		21	26	31	36	41	46	52
19	0.0	0.45	41	51	61	71	82	92	102
20	0.5		33	42	50	58	67	75	84
21	1.0		28	36	43	50	57	64	71
22	1.5		24	30	36	42	48	54	60
23	2.0		20	25	29	34	39	44	49
24	2.5		16	20	24	28	32	36	40
25	0.0	0.50	36	46	55	64	73	82	91
26	0.5		29	37	44	51	58	66	73
27	1.0		24	30	36	42	48	54	61
28	1.5		20	25	30	35	40	45	50
29	2.0		16	20	24	28	32	36	40
30	2.5		12	16	19	22	25	28	31
31	0.0	0.55	33	41	49	57	66	74	82
32	0.5		26	32	39	45	52	58	65
33	1.0		21	26	32	37	42	47	53
34	1.5		17	21	25	29	34	38	42
35	2.0		13	16	20	23	26	29	33
36	2.5		10	12	15	17	20	22	25
37	0.0	0.60	30	37	45	52	59	67	74
38	0.5		23	29	35	40	46	52	58
39	1.0		19	23	28	33	37	42	47
40	1.5		15	18	22	26	29	33	37
41	2.0		11	14	17	19	22	25	28
42	2.5		8	10	12	14	16	18	20

Intermediate values may be obtained by interpolation.

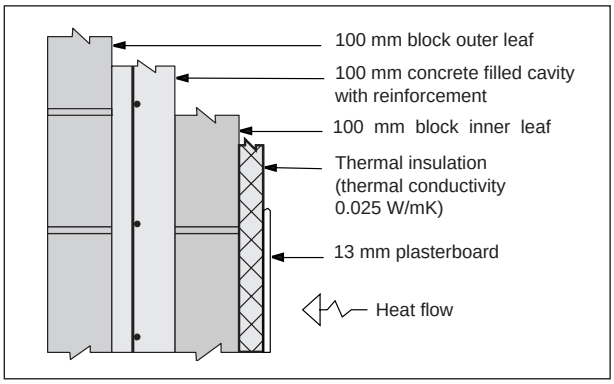
The thickness given against zero basement depth is that which applies to an external wall above ground level.

Table 5A.2 U-value of basement wall (W/m²K) when the same insulating material used in the wall construction above ground is used below ground

	Average depth of basement (m)	U-value (W/m²K) of wall above ground						
		0.30	0.35	0.40	0.45	0.50	0.55	0.60
		Base thickness from Table 5A.1						
		Row 1	Row 7	Row 13	Row 19	Row 25	Row 31	Row 37
	A	B	C	D	E	F	G	H
1	0.5	0.26	0.30	0.35	0.38	0.42	0.46	0.49
2	1.0	0.25	0.28	0.32	0.35	0.38	0.41	0.43
3	1.5	0.23	0.26	0.29	0.32	0.34	0.37	0.39
4	2.0	0.21	0.24	0.27	0.29	0.32	0.34	0.36
5	2.5	0.20	0.23	0.26	0.27	0.29	0.31	0.33

Example 1 - Basement wall with internal lining at constant depth in the surrounding ground

Determine the thickness of insulation layer (with a thermal conductivity value of 0.025 W/mK), required to achieve a U-value of 0.45 W/m²K for the wall construction shown below, having a continuous depth below ground of 2.5 m.

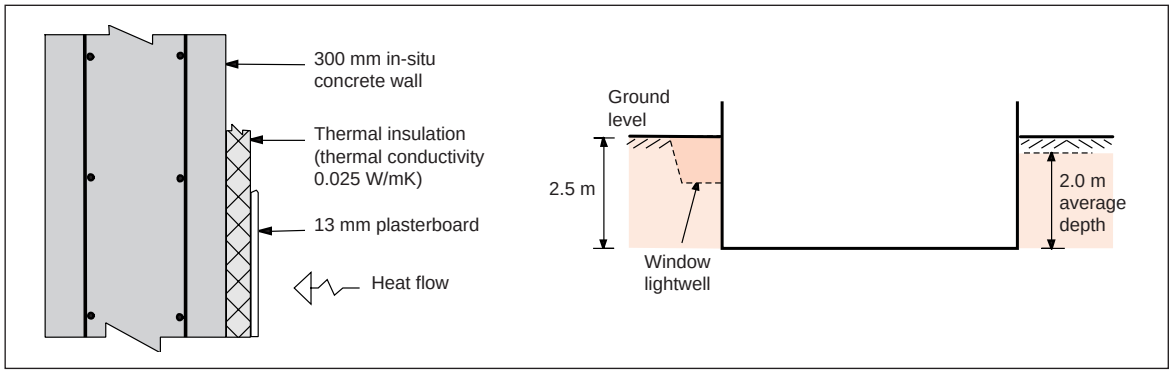


Using Table 5A.1 and taking a wall retaining a continuous 2.5 m depth of soil then: from column C, appropriate for an insulant of 0.025 W/mK, and taking row 24 of the table, for a U-value of 0.45 and a depth of 2.5 m, the base thickness of the insulation is layer is **20 mm**.

The base thickness may be reduced by taking account of other materials (see Appendix A of Approved Document L). A wall protected by a waterproofing system may be taken as an inner leaf wall and a wall not so protected should be taken as an outer leaf or a single leaf wall.

Example 2 - Basement wall with internal lining at varying depth in the surrounding ground

Determine the thickness of insulation (with a thermal conductivity value of 0.025 W/mK) to achieve an average U-value of 0.45 W/m²K for the wall construction shown below, when the average depth as determined from paragraph 5.1.9 is 2.0 m.



Using table 5A.1, from column C, and row 23 for a U-value of 0.45 W/m²K and a depth of 2.0 m, the base thickness of the insulation is layer is **25 mm**.

The base thickness may again be reduced by taking account of other materials (see Appendix A of Approved Document L). Again a wall protected by a waterproofing system may be taken as an inner leaf wall and a wall not so protected should be taken as an outer leaf or a single leaf wall.

Example 3 - Wall with prescribed insulation thickness

Determine the U-value for a basement wall with an average retaining depth of 2.0 m, where the same insulation used to achieve a U-value of 0.45 W/m²K for a wall section above ground is continued down to the basement floor.

By reference to Example 5 of Approved document L, an insulation thickness of **51 mm** (insulant = 0.025 W/mK), is required to achieve a U-value of 0.45 W/m²K above ground. (This is also given in column C, row 19 of Table 5A.1.) If this amount of insulation is continued below ground then:

From Table 5A.2, column E, row 4, a U-value of 0.29 W/m²K is achieved.

The base thickness may again be reduced by taking account of other materials (see Appendix A of Approved Document L). A wall protected by a waterproofing system may be taken as an inner leaf wall and a wall not so protected should be taken as an outer leaf or a single leaf wall.

Note to examples 2 and 3
The insulation indicated should be continuous, but if bridged (eg by battens) an appropriate thickness should be determined by a proportional area calculation.

Table 5A.3 Insulation thickness for solid floors in contact with the ground (U = 0.25 W/m²K)

	Average basement depth H (m)	P/A* ratio	Insulation thickness (mm) for a U-value of 0.25 W/m²K						
			Thermal conductivity of insulant (W/mK)						
			0.02	0.025	0.03	0.035	0.04	0.045	0.05
		A	B	C	D	E	F	G	H
1	0.5	1.0	57	71	85	99	114	128	142
2		0.9	55	69	83	97	111	125	139
3		0.8	54	67	81	94	108	121	135
4		0.7	52	65	77	90	103	116	129
5		0.6	49	61	73	85	97	109	122
6		0.5	45	56	67	78	89	100	112
7		0.4	40	50	60	70	80	90	101
8		0.3	32	40	48	56	64	72	80
9		0.2	16	21	25	29	33	37	41
10	1.0	1.0	53	67	80	93	107	120	134
11		0.9	52	65	78	91	104	117	131
12		0.8	50	63	76	88	101	113	126
13		0.7	48	60	72	84	96	108	121
14		0.6	45	57	68	79	91	102	114
15		0.5	41	52	62	72	83	93	104
16		0.4	37	46	55	64	74	83	92
17		0.3	29	36	43	50	57	64	72
18		0.2	13	17	20	23	26	30	33
19	1.5	1.0	50	63	75	88	100	113	126
20		0.9	49	61	73	85	98	110	122
21		0.8	47	59	71	83	94	106	118
22		0.7	45	56	68	79	90	101	113
23		0.6	42	53	63	74	84	95	105
24		0.5	38	48	57	67	76	86	95
25		0.4	33	42	50	58	67	75	84
26		0.3	25	32	38	44	51	57	64
27		0.2	10	12	15	17	20	22	25
28	2.0	1.0	47	59	70	82	94	105	117
29		0.9	45	57	68	79	91	102	114
30		0.8	44	55	66	77	88	99	110
31		0.7	42	52	62	73	83	94	104
32		0.6	39	48	58	68	77	87	97
33		0.5	35	43	52	61	69	78	87
34		0.4	30	38	45	53	60	68	76
35		0.3	22	28	33	39	44	50	55
36		0.2	6	8	10	11	13	14	16
37	2.5	1.0	43	54	65	76	87	98	109
38		0.9	42	53	63	74	84	95	106
39		0.8	40	51	61	71	81	91	101
40		0.7	38	48	57	67	76	86	96
41		0.6	35	44	53	62	71	80	89
42		0.5	31	39	47	55	63	71	79
43		0.4	27	34	40	47	54	60	67
44		0.3	19	23	28	33	37	42	47
45		0.2	3	4	5	6	6	7	8

* P/A is the ratio of floor perimeter (m) to floor area (m²)

Table 5A.4 Insulation thickness for solid floors in contact with the ground (U = 0.35 W/m²K)

	Average basement depth H (m)	P/A* ratio	Insulation thickness (mm) for a U-value of 0.35 W/m²K						
			Thermal conductivity of insulant (W/mK)						
			0.02	0.025	0.03	0.035	0.04	0.045	0.05
		A	B	C	D	E	F	G	H
1	0.5	1.0	34	43	51	60	68	77	85
2		0.9	33	41	49	57	65	73	82
3		0.8	31	39	47	54	62	70	78
4		0.7	29	36	43	50	58	65	72
5		0.6	27	33	40	47	53	60	67
6		0.5	24	30	35	41	47	53	59
7		0.4	19	23	28	33	37	42	47
8		0.3	11	14	16	19	22	24	27
9		0.2	(0.34)	(0.34)	(0.34)	(0.34)	(0.34)	(0.34)	(0.34)
10	1.0	1.0	31	39	46	54	62	69	77
11		0.9	29	37	44	51	59	66	74
12		0.8	28	35	41	48	55	62	69
13		0.7	25	32	38	44	51	57	64
14		0.6	23	29	35	41	47	53	59
15		0.5	20	25	30	35	40	45	51
16		0.4	15	19	23	27	30	34	38
17		0.3	7	9	11	13	15	17	19
18		0.2	(0.32)	(0.32)	(0.32)	(0.32)	(0.32)	(0.32)	(0.32)
19	1.5	1.0	27	34	41	48	55	62	69
20		0.9	26	33	39	46	52	59	65
21		0.8	24	31	37	43	49	55	61
22		0.7	22	28	33	39	44	50	56
23		0.6	20	25	30	35	40	45	50
24		0.5	17	21	26	30	34	38	43
25		0.4	12	15	18	21	24	27	30
26		0.3	4	5	6	7	8	9	10
27		0.2	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)
28	2.0	1.0	24	30	36	42	48	54	60
29		0.9	23	28	34	40	45	51	57
30		0.8	21	26	32	37	42	47	53
31		0.7	19	24	28	33	38	42	47
32		0.6	17	21	25	29	33	37	42
33		0.5	14	17	20	24	27	31	34
34		0.4	9	11	13	15	17	19	22
35		0.3	1	1	1	1	2	2	2
36		0.2	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)
37	2.5	1.0	21	26	31	36	42	47	52
38		0.9	19	24	29	34	39	44	49
39		0.8	18	22	26	31	35	40	44
40		0.7	15	19	23	27	31	35	39
41		0.6	13	17	20	23	27	30	34
42		0.5	10	13	15	18	20	23	26
43		0.4	5	7	8	9	10	12	13
44		0.3	(0.33)	(0.33)	(0.33)	(0.33)	(0.33)	(0.33)	(0.33)
45		0.2	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)

* P/A is the ratio of floor perimeter (m) to floor area (m²)

Values in brackets are U-values of the uninsulated floor (insulation thickness = 0)

Table 5A.5 Insulation thickness for solid floors in contact with the ground (U = 0.45 W/m²K)

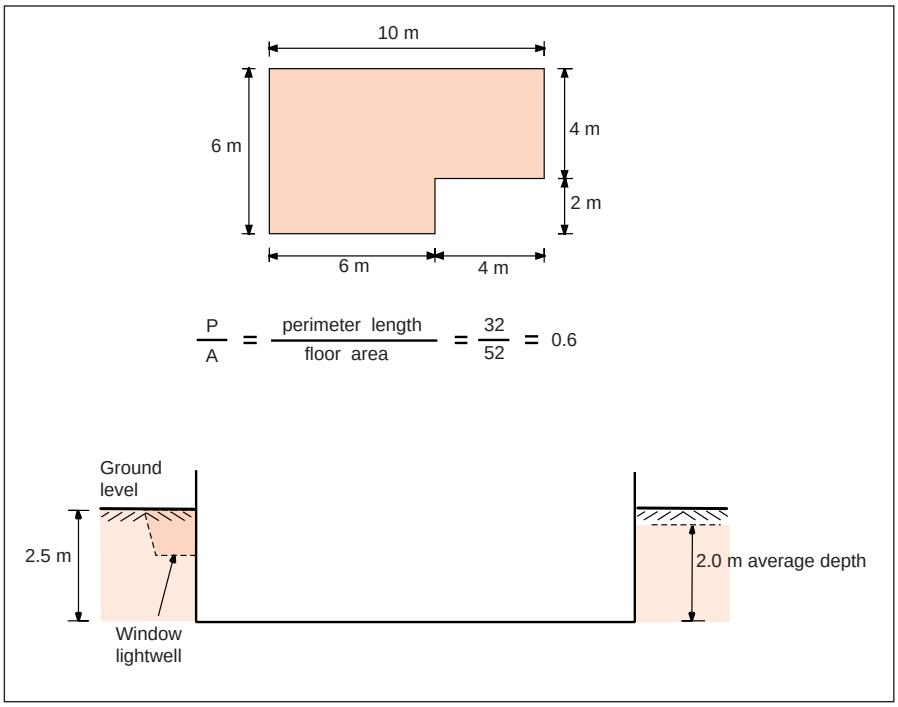
	Average basement depth H (m)	P/A* ratio	Insulation thickness (mm) for a U-value of 0.45 W/m²K						
			Thermal conductivity of insulant (W/mK)						
			0.02	0.025	0.03	0.035	0.04	0.045	0.05
		A	B	C	D	E	F	G	H
1	0.5	1.0	21	27	32	37	43	48	54
2		0.9	20	25	30	35	40	45	50
3		0.8	19	24	28	33	38	42	47
4		0.7	17	22	26	30	34	39	43
5		0.6	15	19	22	26	30	33	37
6		0.5	12	15	17	20	23	26	29
7		0.4	7	9	10	12	14	15	17
8		0.3	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)
9		0.2	(0.34)	(0.34)	(0.34)	(0.34)	(0.34)	(0.34)	(0.34)
10	1.0	1.0	18	23	27	32	36	41	45
11		0.9	17	21	25	29	33	37	42
12		0.8	15	19	23	27	31	35	39
13		0.7	14	17	21	24	28	31	35
14		0.6	12	15	17	20	23	26	29
15		0.5	8	10	12	14	16	18	21
16		0.4	3	4	5	6	7	8	9
17		0.3	(0.41)	(0.41)	(0.41)	(0.41)	(0.41)	(0.41)	(0.41)
18		0.2	(0.32)	(0.32)	(0.32)	(0.32)	(0.32)	(0.32)	(0.32)
19	1.5	1.0	15	19	22	26	30	33	37
20		0.9	13	17	20	23	27	30	34
21		0.8	12	15	18	21	24	27	30
22		0.7	10	13	16	18	21	23	26
23		0.6	8	10	12	14	16	18	21
24		0.5	5	6	7	8	10	11	12
25		0.4	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)	(0.45)
26		0.3	(0.38)	(0.38)	(0.38)	(0.38)	(0.38)	(0.38)	(0.38)
27		0.2	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)
28	2.0	1.0	11	14	17	20	23	26	29
29		0.9	10	13	15	18	20	23	25
30		0.8	9	11	13	15	18	20	22
31		0.7	7	9	11	13	14	16	18
32		0.6	5	6	7	8	10	11	12
33		0.5	2	2	2	3	3	4	4
34		0.4	(0.42)	(0.42)	(0.42)	(0.42)	(0.42)	(0.42)	(0.42)
35		0.3	(0.35)	(0.35)	(0.35)	(0.35)	(0.35)	(0.35)	(0.35)
36		0.2	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)
37	2.5	1.0	8	10	12	14	16	18	20
38		0.9	7	8	10	12	13	15	17
39		0.8	5	7	8	9	11	12	14
40		0.7	4	5	6	7	8	9	10
41		0.6	2	2	2	3	3	4	4
42		0.5	(0.43)	(0.43)	(0.43)	(0.43)	(0.43)	(0.43)	(0.43)
43		0.4	(0.39)	(0.39)	(0.39)	(0.39)	(0.39)	(0.39)	(0.39)
44		0.3	(0.33)	(0.33)	(0.33)	(0.33)	(0.33)	(0.33)	(0.33)
45		0.2	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)

* P/A is the ratio of floor perimeter (m) to floor area (m²)

Values in brackets are U-values of the uninsulated floor (insulation thickness = 0)

Example 4 - Floor with insulation layer

Determine the thickness of insulation layer (with a conductivity of 0.02 W/mK) required to achieve a U-value of 0.45 W/m²K for the basement floor slab shown below.



The thicknesses of insulation to achieve a U-value of 0.45 W/m²K are given in Table 5A.5, from which column B, row 32 indicates **5 mm** of insulation is required.

The insulation may be positioned below the slab only where the slab is not being used to transfer loads to the soil other than those due to weight of the slab alone. In this case, the insulation must be sufficiently robust to withstand the slab weight, have adequate durability and retain its insulating properties. When the insulation is placed above the slab it should be of a type suitable for the flooring it supports.

Note: If the same floor were uninsulated, its U-value would be **0.51** W/m²K (column E, row 4 from Table 5B.1, Appendix 5B).

APPENDIX 5B - CALCULATION METHODS FOR DETERMINING THE U-VALUE AND INSULATION REQUIREMENTS FOR WALLS AND FLOORS OF BASEMENTS

5B.1 GENERAL

5B.1.1 The U-value of elements of construction for basements may be determined from paragraphs 5B.2 and 5B.3. For the basement as a whole use paragraph 5B.4. Alternatively, the U-value of elements of construction for basements may be determined from paragraph 5B.5 which uses the more complex method from PrEN 1190.

5B.1.2 If the basement storey continues above external ground level, the U-value for the wall above ground level should be calculated using the methods for U-value calculation set out in Approved Document L.

5B.1.3 The total area of window and door openings should not normally exceed the percentage of the floor area set out in Approved Document L, depending on the U-value of the glazed areas.

5B.2 U-VALUES OF BASEMENT FLOORS

5B.2.1 The U-value of an uninsulated floor may be determined from Table 5B.1 using an average depth determined from paragraph 5B.2.2.

Table 5B.1 U-values of uninsulated basement floors

	Average depth of basement (m)	U-values (W/m^2K) of uninsulated floors							
		Perimeter to area ratio of floor (P/A)							
		0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2
	A	B	C	D	E	F	G	H	J
1	0.5	0.87	0.82	0.76	0.70	0.63	0.55	0.45	0.34
2	1.0	0.75	0.71	0.67	0.62	0.56	0.49	0.41	0.32
3	1.5	0.66	0.63	0.60	0.56	0.51	0.45	0.38	0.29
4	2.0	0.59	0.57	0.54	0.51	0.47	0.42	0.35	0.28
5	2.5	0.54	0.52	0.49	0.47	0.43	0.39	0.33	0.26

Note: Boxed values show additional insulation is required in order to achieve a U-value of 0.7W/m2K

5B.2.2 The average depth of the basement (*Ha*), taking account of the perimeter ground levels and openings for windows and doors where applicable, can be obtained by using the equation in paragraph 5.1.10.

5B.2.3 Where the U-value of the uninsulated floor is insufficient to meet the insulation requirements, the additional insulation needed may be determined from paragraphs 5B.2.4 and 5B.2.5.

5B.2.4 Using the calculated average depth, *Ha*, determine from Table 5B.2 the thermal resistance which should be incorporated into the basement floor to achieve a U-value of 0.25, 0.35 or 0.45 W/m^2K as appropriate . The thermal resistance R_f for an alternative U-value should be obtained from the simplified equation:

$$R_f = \frac{1}{U_{reqd}} - \frac{1}{U_o}$$

Where U_o is as given in Table 5B.1

For the purpose of this calculation the thermal resistance of the insulation layer and floor finish only should be taken.

5B.2.5 The thickness of insulation to achieve the resistance values given in Table 5B.2 may be obtained from the following equation:

$$\text{Thickness, } t = R_f \times \lambda$$

Where

R_f is the thermal resistance as determined from paragraph 5B.2.4.

λ is the thermal conductivity of the insulation material, preferably obtained from certified test values provided by manufacturers of proprietary materials. (For values of some common materials see Table 5B.3.)

Table 5B.2 Thermal resistance R_f (m^2K/W) needed to achieve given U-value for basement floors

	Average depth of basement (m)	Thermal resistance (R_f) needed to achieve indicated U-value							
		Perimeter to area ratio of floor (P/A)							
		0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2
	A	B	C	D	E	F	G	H	J
	U = 0.45 W/m^2K for basement floors								
1	0.5	1.07	1.00	0.91	0.79	0.62	0.39	0.01	*
2	1.0	0.89	0.82	0.73	0.60	0.44	0.19	*	*
3	1.5	0.72	0.64	0.55	0.43	0.26	0.00	*	*
4	2.0	0.54	0.47	0.38	0.25	0.08	*	*	*
5	2.5	0.36	0.29	0.20	0.08	*	*	*	*
	U = 0.35 W/m^2K for basement floors								
6	0.5	1.70	1.63	1.54	1.42	1.26	1.02	0.64	*
7	1.0	1.53	1.45	1.36	1.24	1.07	0.83	0.43	*
8	1.5	1.35	1.28	1.19	1.06	0.89	0.64	0.23	*
9	2.0	1.18	1.10	1.01	0.89	0.71	0.46	0.04	*
10	2.5	1.00	0.93	0.84	0.71	0.54	0.28	*	*
	U = 0.25 W/m^2K for basement floors								
11	0.5	2.85	2.77	2.68	2.56	2.40	2.17	1.79	1.07
12	1.0	2.67	2.60	2.50	2.38	2.21	1.97	1.57	0.83
13	1.5	2.50	2.42	2.33	2.20	2.03	1.78	1.37	0.60
14	2.0	2.32	2.25	2.15	2.03	1.86	1.60	1.18	0.39
15	2.5	2.14	2.07	1.98	1.85	1.68	1.42	1.00	0.19

Simplified method $R_f = 1/U_{reqd} - 1/U_o$

* The uninsulated floor has a U-value equal to or less than the indicated U-value.

5B.3 U-VALUES OF BASEMENT WALLS

5B.3.1 Table 5B.4 gives U-values of basement walls as a function of the average basement depth *Ha*, and the thermal resistance R_w of the basement walls. Linear interpolation should be used to obtain intermediate values. In the calculation of R_w include the resistance of all layers in the basement wall, including masonry. However, do not include the surface resistances, as their effect is already incorporated in the U-values given in Table 5B.4. If any of the layers are bridged (eg by timber studding, or by mortar joints between low-density blocks), R_w must be determined by a proportionate area calculation.

5B.3.2 The average depth of the basement may be determined by using the equation in paragraph 5.1.9.

Table 5B.3 Thermal conductivity of some common building materials

Material	Density (kg/m³)	Thermal conductivity (W/mK)
Floors		
Cast concrete	2000	1.13
Screed	1200	0.41
Wood chipboard	700	0.15
Wood blocks	650	0.14
Walls		
Brickwork (outer leaf)	1700	0.84
Brickwork (inner leaf)	1700	0.62
Cast concrete (dense)	2100	1.40
Cast concrete (lightweight)	1200	0.38
Concrete block (heavyweight)	2300	1.63
Concrete block (mediumweight)	1400	0.51
Concrete block (lightweight)	600	0.19
Normal mortar	1750	0.80
Surface finishes		
Cement render	1300	0.50
Dense plaster	1300	0.50
Lightweight plaster	600	0.16
Calcium silicate board	875	0.17
Fibreboard	300	0.06
Plaster board	950	0.16
Timber	650	0.14
Insulation		
Expanded polystyrene (EPS) slab	*	*
Mineral wool quilt	*	*
Mineral wool slab	*	*
Phenolic foam board	*	*
Polyurethane board	*	*

Note: * For insulation, use certified test results. If they are available for other materials, test results should be used in preference to the values given in the table.

Table 5B.4 U-values (W/m²K) of basement walls

Thermal resistance, R_w, of basement wall (m²K/W)	Basement depth, H_a (m)				
	0.5	1.0	1.5	2.0	2.5
0.5	1.02	0.82	0.69	0.60	0.54
1.0	0.66	0.56	0.50	0.45	0.41
1.5	0.49	0.43	0.39	0.36	0.33
2.0	0.39	0.35	0.32	0.30	0.28
2.5	0.32	0.30	0.27	0.25	0.25

5B.4 U-VALUE OF BASEMENT AS A WHOLE

5B.4.1 The average U-value for the basement storey can be calculated using the equation:

$$U_{ave} = \frac{A_f U_{bf} + H_a P U_{bw} + A_w U_w}{A_f + A_w + H_a P}$$

where:

U_{ave} is the average U-value of basement (W/m²K)
U_{bf} is the U-value of basement floor (W/m²K)
U_{bw} is the U-value of basement walls below ground level (W/m²K)
U_w is the U-value of walls above external ground level within the basement storey (W/m²K)
P is the perimeter of basement floor (m)
A_f is the area of basement floor (m²)
H_a is the average depth of basement below ground level (m)
A_w is the area of wall above external ground level within the basement storey (m²)

P is measured along the finished internal faces.

A_f is the area within the finished internal faces of the walls bounding the basement.

A_w is area between the outside ground level and the underside of the floor over the basement.

H_a is measured in metres between the outside ground level and the finished internal surface of the basement floor. H_a will generally be less than the internal height of the basement storey. In this case the U-values derived from the tables in this Approved Document will apply only to the area of wall below external ground level.

5B.4.2 When using paragraph 5B.4.1, the U-value of the floor and wall elements may be determined from paragraphs 5B.2 and 5B.3.

5B.4.3 When using the Elemental method, the requirements for an SAP energy rating of over 60 will be met where the average U-value of the basement as determined by paragraph 5B.4.1 is equal to or less than 0.45 W/m²K.

5B.4.4 If the average U-value does not meet the requirement when using the Elemental method, the building can still be acceptable providing the average U-value of the building meets the Target value given in paragraph 5.3.2. This will require adjustments to be made, which could include:

(a) Improving the thermal resistance of one or more elements of the structure;
(b) Amending the positions and sizes of windows and doors to take advantage of solar gain;
(c) Installing more efficient space heating equipment.

5B.5 U-VALUES DETERMINED BY PrEN 1190

5B.5.1 Paragraph 5B.5.4 gives the procedure and equations from PrEN 1190 used to determine the heat transfer from a basement and U-values of wall and floor elements.

5B.5.2 The meaning and units of the symbols used in the following paragraphs and equations are given below:

A	area of the floor	m²
B'	characteristic dimension of the floor	m
H	depth of basement floor below ground level	m
L_s	steady-state thermal coupling coefficient	W/K

P	exposed perimeter of floor	m
R	thermal resistance	m^2K/W
R_f	thermal resistance of floor construction	m^2K/W
U_{bf}	thermal transmittance of basement floor	W/m^2K
U_{bw}	thermal transmittance of basement wall	W/m^2K
d_t	total equivalent thickness of floor	m
d_w	total equivalent thickness of wall	m
w	thickness of external walls to building	m
λ	thermal conductivity of unfrozen ground	W/mK

5B.5.3 The surface resistances to be used with the equations are as follows:

R_{si}	internal, downwards heat flow	= 0.14 m^2K/W
R_{si}	internal, horizontal heat flow	= 0.12 m^2K/W
R_{si}	internal, upwards heat flow	= 0.10 m^2K/W
R_{se}	external, in all cases	= 0.04 m^2K/W

5B.5.4 For a heated basement, L_s is given by:

$$L_s = AU_{bf} + HPU_{bw}$$

This equation gives the heat transfer from the whole basement. The heat transfers through the floor and walls of the basement are linked, and for this reason the terms in this equation for the heat transfer through the floor and walls are approximations.

To determine U_{bf} calculate B', and include any insulation of the basement floor in the total equivalent thickness d_t where:

$$B' = \frac{A}{0.5P}$$

$$d_t = w + \lambda(R_{si} + R_f + R_{se})$$

where R_f includes any all-over insulation layers above, below or within the floor slab, and that of any covering. (Note: the resistance R_f should be taken as zero for a dense concrete slab and a value of the resistance of the floor slab minus 0.1 for a lightweight concrete slab.)

The thermal resistance of dense concrete slabs and thin coverings may be neglected. Hardcore below the slab is assumed to have the same thermal conductivity as the ground and its thermal resistance should be neglected.

Use one of the following equations, depending on the thermal insulation of the basement floor.

If $(d_t + 0.5H) < B'$ (uninsulated and moderately insulated basement floor):

$$U_{bf} = \frac{2\lambda}{\pi B' + d_t + 0.5H} \ln\left(\frac{\pi B'}{d_t + 0.5H} + 1\right)$$

If $(d_t + 0.5H) \oplus B'$ (well insulated basement floor):

$$U_{bf} = \frac{\lambda}{0.457B' + d_t + 0.5H}$$

U_{bw} depends on the total equivalent thickness of the basement walls, d_w where:

$$d_w = \lambda(R_{si} + R_w + R_{se})$$

where R_w includes the wall and any insulation layers.

Obtain U_{bw} from:

$$U_{bw} = \frac{2\lambda}{\pi H}\left(1 + \frac{0.5d_t}{d_t + H}\right)\ln\left(\frac{H}{d_w} + 1\right)$$

The formula for U_{bw} involves both d_w and d_t. It is valid for $d_w > d_t$ which is usually the case. If, however, $d_w < d_t$ then d_t should be replaced by d_w.

5B.5.5 For the thermal properties of the ground:

(a) If known, use values for the actual location, averaged over a depth equal to the width of the building and allowing for the normal moisture content; otherwise

(b) If the soil type is known or specified, use the values in Table 5B.5; otherwise

(c) Use λ = 2.0 W/mK.

Table 5B.5 Thermal conductivity of the ground

Category	Description	Thermal conductivity
1	Clay or silt	1.5
2	Sand or gravel	2.0
3	Homogeneous rock	3.5
Note: 2.0 W/mK was used for the Tables in Appendices 5A and 5B		

5B.5.6 For the thermal resistance of any building product, use certified test results when available. Alternatively use the appropriate design value as defined in the appropriate European Standards or European Technical Approval. The thermal resistance of products used below ground level should reflect the moisture conditions of the application. The heat capacity of floor materials should be neglected.

6 VENTILATION

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part F of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document F should also be followed or the requirements should be met in some other way.

REQUIREMENT	LIMITS ON APPLICATION
F1 MEANS OF VENTILATION There shall be adequate means of ventilation provided for people in the building.	Requirement F1 does not apply to a building or space within a building – (a) into which people do not normally go; or (b) which is used solely for storage; or (c) which is a garage used solely in connection with a single dwelling.
F2 CONDENSATION Adequate provision shall be made to prevent excessive condensation – (a) in a roof; or (b) in a roof void above an insulated ceiling.	

6.1 PROVISION FOR VENTILATION

6.1.1 **F1** All habitable rooms, kitchens, utility rooms, sanitary accomodation and bathrooms located within the basement storey should follow the ventilation provisions of Approved Document F.

6.1.2 ***GP*** *In order to prevent condensation in heated or unheated non-habitable rooms in basements not listed above (such as storerooms and workshops) it is recommended that ventilation should follow the provisions given in Approved Document F for the ventilation of non-habitable rooms not containing openable windows.*

6.1.3 ***GP*** *Because air infiltration/leakage in basements will generally be less than in storeys above ground level, it is desirable to provide cross flow background ventilation to habitable rooms. There should be approximately equal areas of adjustable background ventilation openings on opposite or adjoining sides of the basement, which may be subdivided by normal internal walls and doors (Figure 6.1). There should be a 10 mm gap under internal doors (or equivalent opening).*

6.1.4 ***GP*** *Where a basement is single sided (Figure 6.2), an opening for background ventilation should be provided in the exposed face, and this should be supplemented by an equivalent area of background ventilation to provide cross ventilation. This can be achieved by installing ventilation ducts, mechanical ventilation, or a passive stack ventilation system (either provided in accordance with BRE Information Paper 13/94, or consisting of a proprietary system with third party certification).*

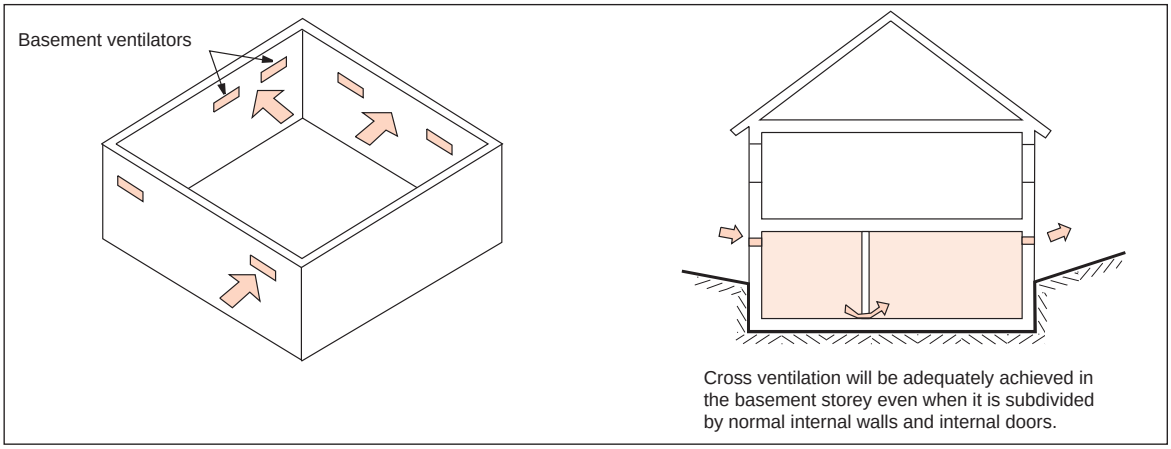


Figure 6.1 Cross ventilation to the basement storey

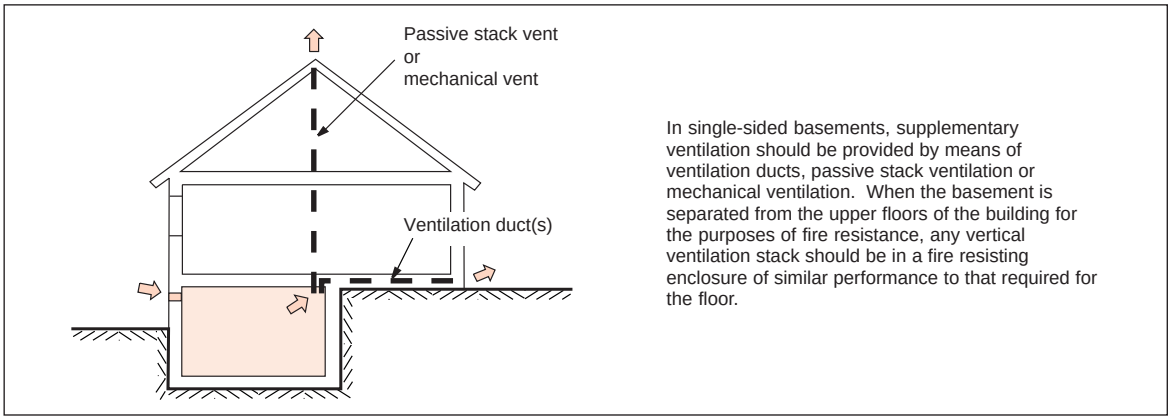


Figure 6.2 Ventilation of single-sided basements

7 RESISTANCE TO THE PASSAGE OF SOUND

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part E of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document E should also be followed or the requirements should be met in some other way.

REQUIREMENT	LIMITS ON APPLICATION
E1 AIRBORNE SOUND (WALLS) A wall which – (a) separates a dwelling from another building or from another dwelling; or (b) separates a habitable room or kitchen within a dwelling from another part of the same building which is not used exclusively as part of the dwelling, shall resist the transmission of airborne sound.	
E2 AIRBORNE SOUND (FLOORS AND STAIRS) A floor or a stair which separates a dwelling from another dwelling, or from another part of the same building which is not used exclusively as part of the dwelling, shall resist the transmission of airborne sound.	
E3 IMPACT SOUND (FLOORS AND STAIRS) A floor or a stair above a dwelling which separates it from another dwelling, or from another part of the same building which is not used exclusively as part of the dwelling, shall resist the transmission of impact sound.	

7.1 WALLS

7.1.1 **E1** When basement walls separate a dwelling from another building or another dwelling they should resist the transmission of airborne sound.

7.1.2 **E1** Due to the structural design criteria for basement retaining walls, the requirements for walls can be satisfied by the specification of wall Types 1, 3a, 3b and 3c and the relevant junction details described in Approved Document E, with the exception that the separating wall may abut the external wall using the construction shown in Figure 7.1(b).

7.1.3 **E1** Examples of construction for each of these wall types are given in Approved Document E. However, for the construction to be fully effective, care should be taken to detail the junctions of the separating wall and other elements such as the perimeter walls, the floors and the partitions.

7.1.4 **E1** The junctions between separating walls and the perimeter walls of the basement should be resistant to the passage of sound (Figure 7.1).

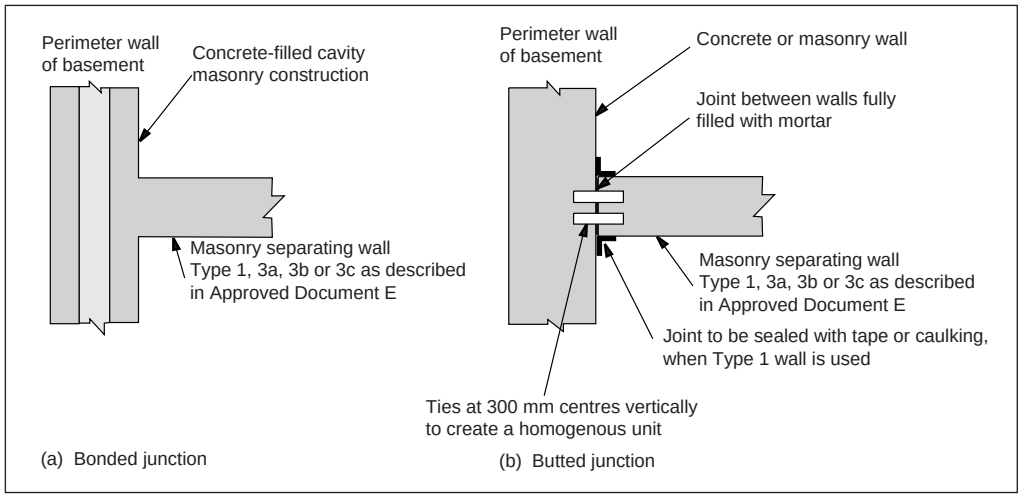


Figure 7.1 Plan view of junction of separating wall with basement perimeter wall

7.2 FLOORS AND STAIRS

7.2.1 **E2/3** When the floor/stair between the basement storey and the ground floor storey separates a dwelling (or part of a dwelling) at ground floor level from another part of the building which is not used exclusively as part of the dwelling it should resist the transmission of airborne sound.

7.2.2 **E2/3** When the floor/stair between the basement storey and the ground floor storey separates a dwelling (or part of a dwelling) in the basement from another building or another dwelling it should resist the transmission of airborne and impact sound.

7.2.3 **E2/3** The requirements for floors can be satisfied by the specification of one of the three separating floor types and the relevant junction details described in Approved Document E.

8 STAIRS, RAMPS AND GUARDS

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part K of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document K should also be followed or the requirements should be met in some other way.

REQUIREMENT	LIMITS ON APPLICATION
K1 STAIRS AND RAMPS Stairs, ladders and ramps shall offer safety to users moving between levels of a building.	1. The requirements of this Part apply to stairs, ladders and ramps which form part of the building. 2. Requirement K1 does not apply to stairs, ladders and ramps which provide access to levels used only for the purpose of maintenance.
K2 PROTECTION FROM FALLING Stairs, ramps, floors and balconies, and any roof to which people normally have access, shall be guarded with barriers where they are necessary to protect users from the risk of falling.	
K3 VEHICLE BARRIERS Vehicle ramps, and any floor and roof to which vehicles have access, shall be guarded with barriers where they are necessary to provide protection for people in or about the building.	

8.1 STAIRS AND RAMPS

8.1.1 **K1** Any staircase or ramp providing access to a basement should follow the provisions described in Approved Document K, Section 1.

8.2 GUARDS

8.2.1 **K2/3** The provisions described in Approved Document K for pedestrian guarding should be applied at any change in level where there is risk of injury by falling.

8.2.2 ***GP***

When external ground levels are cut away to provide lightwells to basement windows, a safety guard 1100 mm high complying with the requirements of Approved Document K should be provided where the angle of slope exceeds 26.5° (1 in 2), but is not greater than 45°, and where the vertical dimension from the top to the lowest point of the slope exceeds 600 mm (Figure 8.1a). A safety guard 1100 mm high should also be provided when a retaining wall or other vertical enclosure at an angle greater than 45° is used at a lightwell, unless the vertical dimension of the change in level is less than 380 mm (Figure 8.1b). (The limit suggested here is in place of the vertical 600 mm dimension given in Approved Document K as lightwells are an unfamiliar hazard.) For strength of guards see BS 6399.

A safety guard need not be provided where the conditions in Figures 8.1a or 8.1b are not exceeded or at the top of a slope whose angle is 26.5° or less (Figure 8.1c).

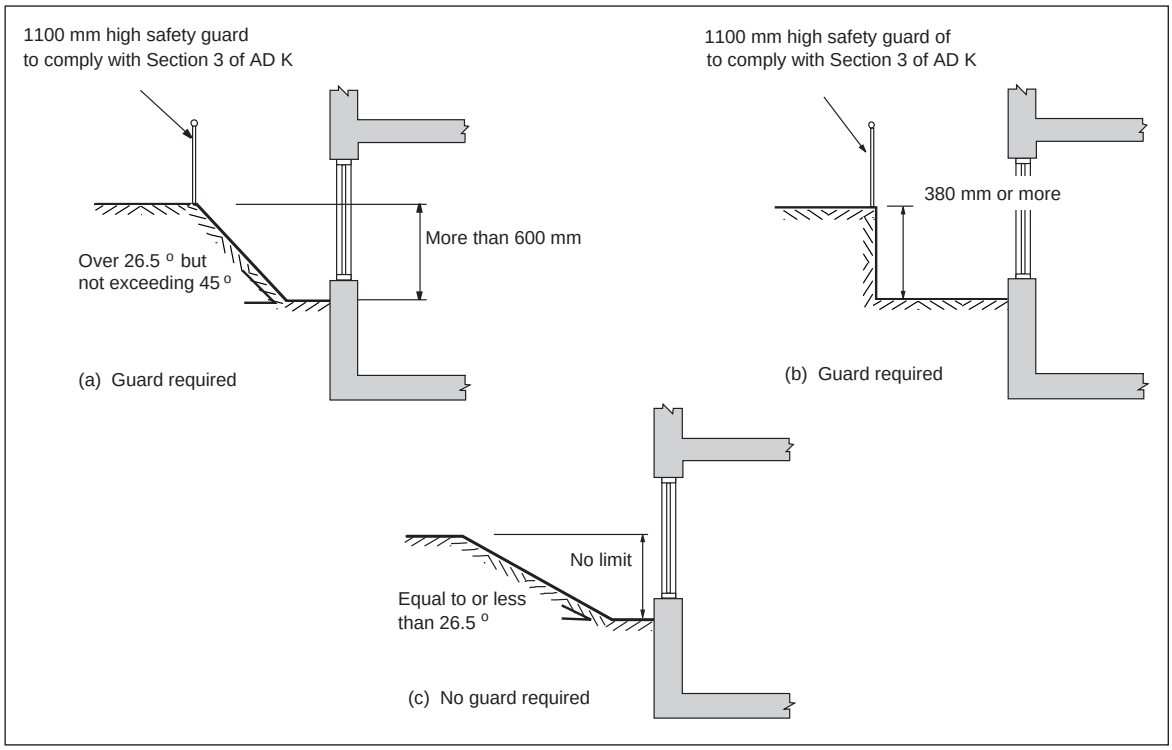


Figure 8.1 Requirements for guards to lightwells

9 GLAZING – MATERIALS AND PROTECTION

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part N of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document N should also be followed or the requirements should be met in some other way.

REQUIREMENT		LIMITS ON APPLICATION
N1	**INTERPRETATION** Glazing with which people are likely to come into contact while in passage in or about the building, shall – (a) if broken on impact, break in a way which is unlikely to cause injury; or (b) resist impact without breaking; or (c) be shielded or protected from impact.	
N2	Transparent glazing, with which people are likely to collide while in passage in or about the building, shall incorporate features which make it apparent.	Requirement N2 does not apply to dwellings.

9.1 GENERAL

9.1.1 **N1** Glazing which is within 800 mm of the external ground or floor level and is not protected by protective barriers (Figure 9.1) should satisfy the test requirements of Class C, as defined in BS 6206: 1981 *Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.* If it is installed in a door or in a door side panel and has a pane width exceeding 900 mm, the glass should meet class B if it is within 1500 mm of the ground or floor.

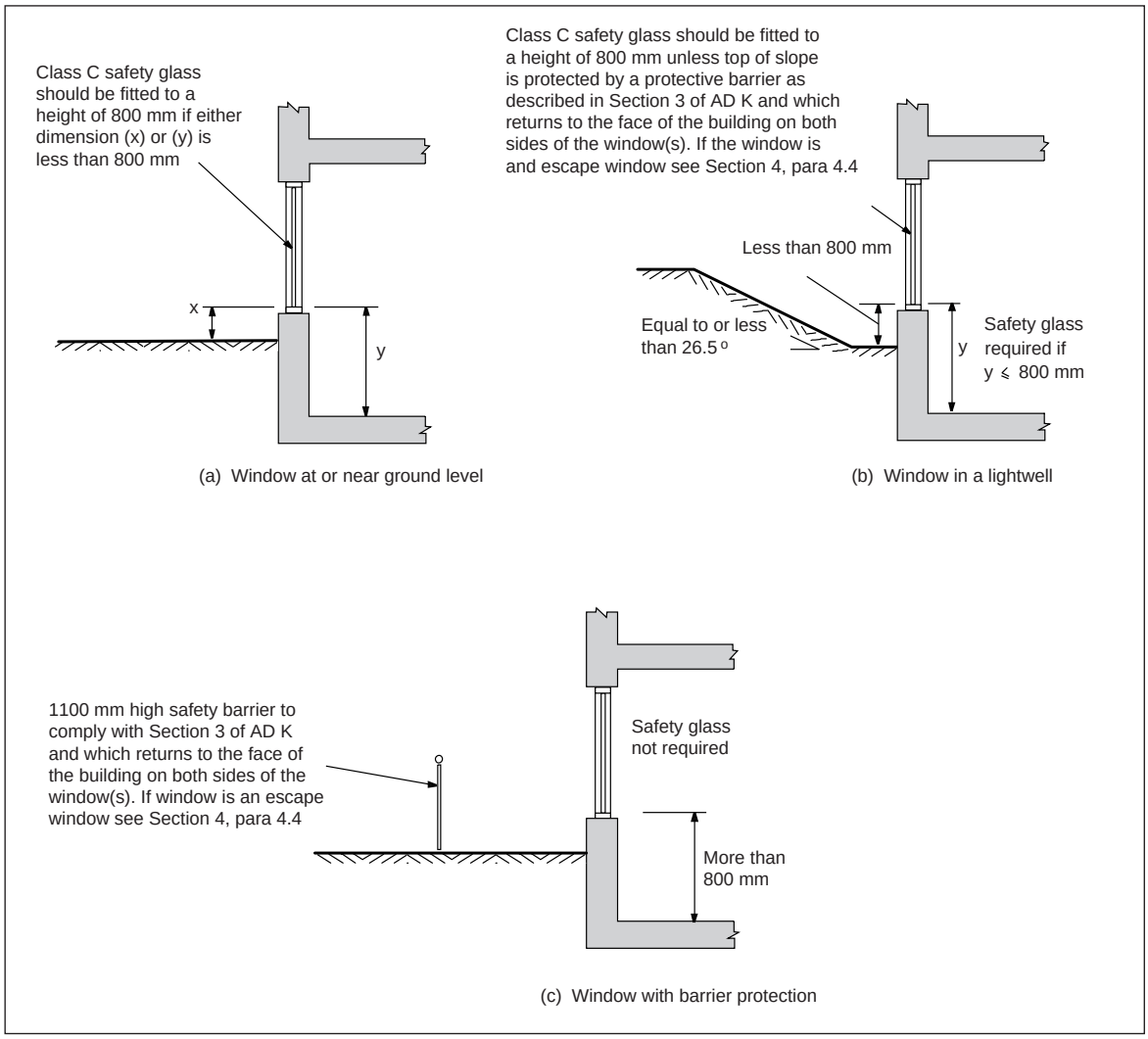


Figure 9.1 Requirements for safety glazing in windows to the basement

10 DRAINAGE AND WASTE DISPOSAL

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part H of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document H should also be followed or the requirements should be met in some other way.

REQUIREMENT	LIMITS ON APPLICATION
H1 FOUL WATER DRAINAGE (1) Any system which carries foul water from appliances within the building to a sewer, a cesspool or a septic, or settlement tank shall be adequate. (2) 'Foul water' in sub-paragraph (1) means waste water which comprises or includes – (a) waste from a sanitary convenience or other soil appliance, (b) water which has been used for cooking or washing.	
H2 CESSPOOLS, SEPTIC TANKS AND SETTLEMENT TANKS Any cesspool, septic tank and settlement tank shall be – (a) of adequate capacity and so constructed that it is impermeable to liquids; (b) adequately ventilated; and (c) so sited and constructed that – (i) it is not prejudicial to the health of any person (ii) it will not contaminate any underground water or water supply, and (iii) there are adequate means of access for emptying.	
H3 RAINWATER DRAINAGE Any system which carries rainwater from the roof of the building to a sewer, a soakaway, a water course or some other suitable rainwater outfall shall be adequate.	
H4 SOLID WASTE WATER STORAGE (1) Adequate means of storing solid waste shall be provided (2) Adequate means of access shall be provided – (a) for people in the building to the place of storage; and (b) from the place of storage to a street.	

10.1 FOUL DRAINAGE

10.1.1 **H1** Pipe work and drainage installed in a basement storey should comply with the requirements of Approved Document H and the recommendations of BS 8301: *Code of Practice for building drainage.*

10.1.2 ***GP*** *Where there are no drainage connections at basement level, the soil stack should where possible be maintained on the external side of the basement waterproofing system (Figure 10.1).*

The use of a macerator and pump small-bore drainage system discharging into the gravity system at ground floor level will obviate the need for pipes to penetrate the basement structure and will enable connections to be made to external drainage at a shallower depth. (See also paragraph 10.1.5.)

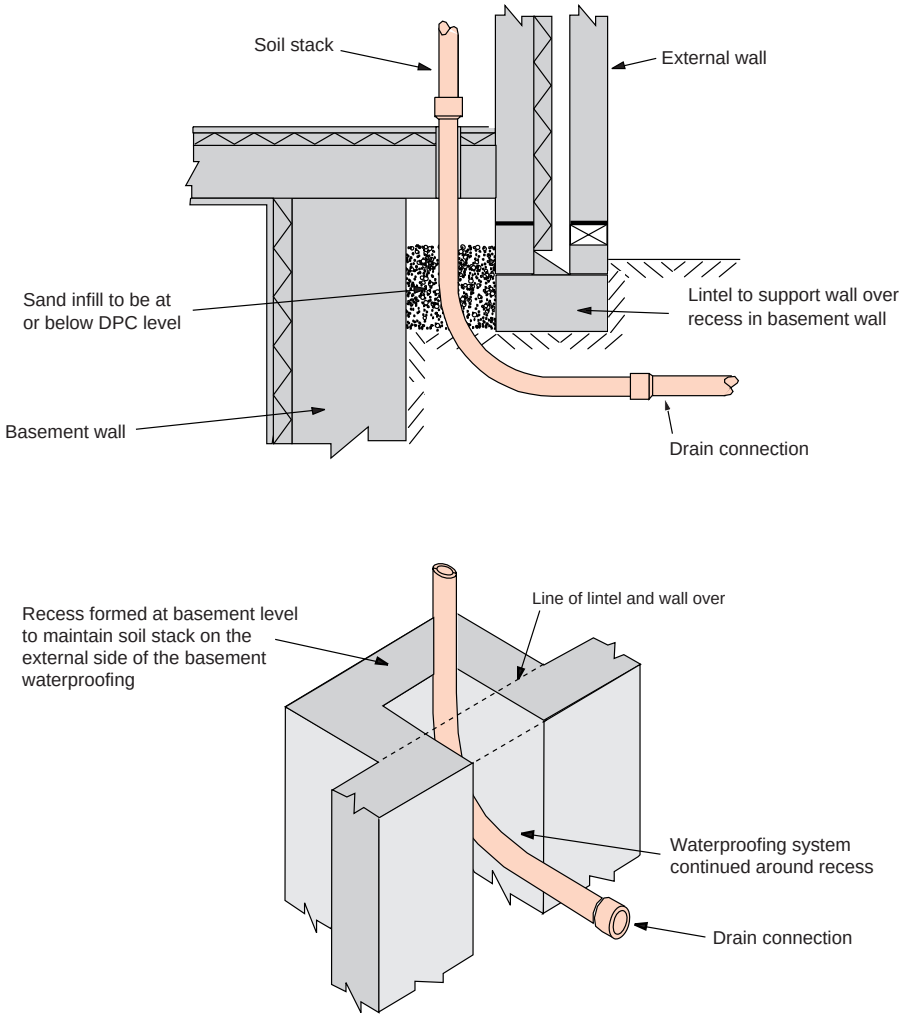


Figure 10.1 Drainage connection avoiding penetration of the waterproofing system by the soil stack

10.1.3 **H1** Where surcharge can occur (ie if the top of the external access point is above the upper surface of the basement floor) drainage connections which connect to appliances at basement level should be made through a flood-valve (see BS 8301).

10.1.4 **H1** Connections through the basement structure should make allowance for differential movement of the pipe and the structure. The first joint in the pipe should be not more than 150 mm from the basement wall, and the first connecting pipe should be not more than 600 mm in length with flexible joints at both ends. The pipe bedding should be of a type that will allow differential movement between the pipe and the basement structure (Figure 10.2).

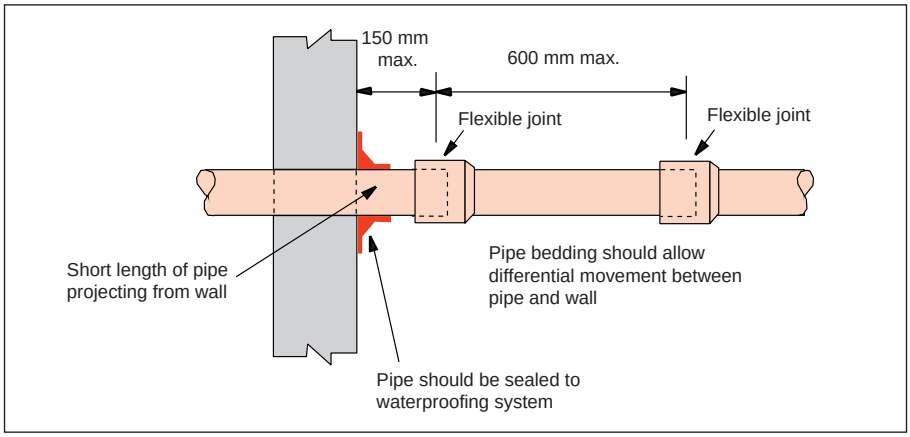


Figure 10.2 Requirements for a drain connection penetrating the basement wall

10.1.5 **H1** Where a gravity connection to the sewer is not possible, sewage-lifting equipment will be needed. Guidance on sewage-lifting installations is contained in BS 8301: *Code of Practice for building drainage*.

Note
Another installation not dependent on a pump should be provided elsewhere in the premises (see Approved Document G, paragraph 1.10a).

10.2 SURFACE WATER AND GROUND WATER DRAINAGE

10.2.1 **H3** Surface water drainage should comply with the requirements of Approved Document H and the recommendations of BS 8301: *Code of Practice for building drainage*.

10.2.2 **H3** Drainage connections to access ramps falling towards private garages should incorporate an interceptor trap, or a trapped gully with a sump which can be cleaned.

10.2.3 **H3** Discharge of ground water to an outfall should normally be made through a catchpit designed to intercept and retain soil particles and other suspended matter

10.2.4 **H3** Access areas at basement level and lightwells to windows should be provided with surface water drainage to prevent flooding. Gullies should be designed to be resistant to blockage by debris, and on sloping sites there should be provisions to direct water away from lightwells.

10.2.5 **H3** Ground water drainage used to alleviate sub-soil water pressure, or to provide drainage at the lowest level of a basement structure, should discharge either directly or through a catchpit into a watercourse, or through a catchpit into a soakaway. Where neither of these is possible, it may discharge through a catchpit into a surface water sewer, a combined sewer or a foul sewer. A connection to a surface water sewer or a combined or foul sewer should be made through a reverse-acting disconnecting trap. Where the drainage system discharges to a public sewer, the approval of the drainage authority should be obtained.

10.2.6 **H3** Where gravity connection is not possible, water-lifting equipment will be needed. Guidance on water-lifting equipment is given in BS 8301: *Code of Practice for building drainage.*

10.2.7 **H3** When a soakaway is connected to the outfall of a surface water or ground water drainage system, the soakaway should be located not less than 5 metres from the basement structure and, in the case of a sloping site, at the lowest level relative to the building.

11 HEAT PRODUCING APPLIANCES

THE REQUIREMENTS

This section of this Approved Document gives guidance on ways of meeting the following requirements in Part J of Schedule 1 to the Building Regulations 1991 (as amended) when the building includes a basement. Unless noted otherwise in this section, the guidance in Approved Document J should also be followed or the requirements should be met in some other way.

REQUIREMENT	LIMITS ON APPLICATION
J1 AIR SUPPLY Heat producing appliances shall be so installed that there is an adequate supply of air to them for combustion and for efficient working of any flue-pipe or chimney.	The requirements in this Part apply only to fixed heat producing appliances which – (a) are designed to burn solid fuel, oil, or gas; or (b) are incinerators.
J2 DISCHARGE OF PRODUCTS OF COMBUSTION Heat producing appliances shall have adequate provision for the discharge of the products of combustion to the outside air.	
J3 PROTECTION OF BUILDING Heat producing appliances and flue-pipes shall be so installed, and fireplaces and chimneys shall be so constructed, as to reduce to a reasonable level the risk of the building catching fire in consequence of their use.	

11 HEAT PRODUCING APPLIANCES

11.1 GENERAL

11.1.1 **J** Heat producing appliances installed in a basement should be installed in accordance with the requirements of Parts J/1/2/3 of the Building Regulations. A way of showing compliance would be to follow the guidance in Approved Document J.

Note
It should be noted that gas appliances should also be installed in accordance with the Gas Safety (Installation & Use) Regulations, which can limit the use of certain LPG appliances in basements.

11.1.2 ***GP*** *LPG storage containers should not be located in basements.*

11.1.3 ***GP*** *When LPG installations are fitted in buildings with a basement, an LPG detector complying with BS 7348 should be fitted not more than 200 mm above the floor of the basement unless low level direct ventilation to the outside is possible, for example, by permanent openings not more than 200 mm above the floor on walls exposed by a sloping site.*

11.2 AIR SUPPLY

11.2.1 **J1** The room or space containing the appliance should have a provision for introducing air to the appliance at least equal to that defined in Sections 1 and 2 of Approved Document J or, the appliance should be room-sealed.

11.3 DISCHARGE OF PRODUCTS OF COMBUSTION

11.3.1 **J2** When room-sealed appliances are installed in the basement storey, any flue terminal should be sited so that it is at least 300 mm above the external ground level and positioned so that it cannot be blocked by, for example, leaves or snow.

11.3.2 **J2** A balanced flue terminal should not be located in a lightwell or similar area below external ground level where the combustion products could become trapped as a result of wind pressure on the building.

12 VEHICLE ACCESS

12.1 VEHICLE ACCESS

12.1.1 ***GP***

Vehicle access ramps to single-family dwellings should not be steeper than 1 in 6 and the transition points should be removed to prevent vehicles grounding. Ramps to basement car parking beneath blocks of flats should not exceed 1 in 10, or 1 in 7 for short lengths with a transition length at the top and bottom of the ramp (Figure 12.1).

12.1.2 ***GP***

The surface of the ramp should have a textured or ribbed surface.

12.1.3 ***GP***

Ramps falling toward the basement should incorporate drainage channels to collect the rainwater from the sloping surface and divert it to a suitable outfall (ie, a land drain or a surface water drain).

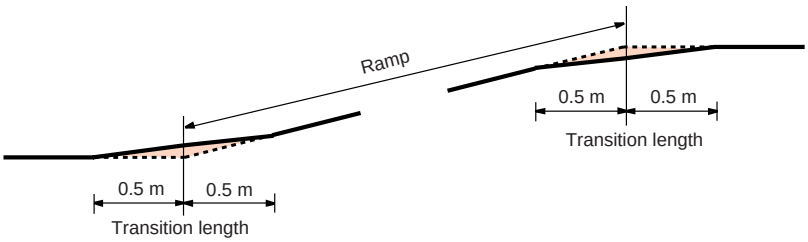


Figure 12.1 Provision of transition length in ramps steeper than 1 in 10

STANDARDS

BS 187: 1978 *Specification of calcium silicate (sandlime and flintlime) bricks.*
Amendment slip number 1: AMD 5427.

BS 476: *Fire tests on building materials and structures,*
Part 22: 1987 *Methods for determination of the fire resistance of non-loading elements of construction.*

BS 729: 1971 (1994) *Specification for hot dip galvanized coatings on iron and steel articles.*

BS 970: *Specification for wrought steels for mechanical and allied engineering purposes.*
Part 1: 1991 *General specification and testing procedures and specific requirements for carbon, carbon manganese, alloy and stainless steels.*
Amendment slip number 1: AMD 7226
2: AMD 8973.

BS 1243: 1978 *Specification for metal ties for cavity wall construction.*
Amendment slip number 1: AMD 3651
2: AMD 4024.

BS 3921: 1985 *Specification for clay bricks.*
Amendment slip number 1: AMD 8946.

BS 4449: 1988 *Specification for carbon steel bars for reinforcement of concrete.*

BS 4483: 1985 *Specification for steel fabric for reinforcement of concrete.*

BS 5328: *Concrete*:
Part 1: 1997 *Guide to specifying concrete.*
Part 2: 1997 *Methods for specifying concrete mixes*

BS 5628: *Code of practice for use of masonry*:
Part 1: 1992 *Structural use of unreinforced masonry.*
Amendment slip number 1: AMD 7745,
Part 2: 1995 *Structural use of reinforced and prestressed masonry,*
Part 3: 1985 *Materials and components, design and workmanship.*
Amendment slip number 1: AMD 4974.

BS 6073: 1981 *Specification for precast concrete masonry units.*
Amendment slip number 1: AMD 4508.

BS 6206: 1981 *Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.*
Amendment slip number 1: AMD 4580
2: AMD 5189
3: AMD 7589
4: AMD 8693.

BS 6399: Part 1, 1996. *Loadings for buildings. Code of practice for dead and imposed loads.*

BS 6649: 1985 *Specification for clay and calcium silicate modular bricks.*

BS 6744: 1986 *Specification for austentic stainless steel bars for the reinforcement of concrete.*

BS 7348: 1990 *Specification for electrical apparatus for detection of combustible gases in domestic premises.*
Amendment slip number 1: AMD 6869.

BS 8002: 1994 *Code of practice for earth retaining structures*

BS 8004: 1986 *Code of practice for foundations.*

BS 8007: 1987 *Code of practice for design of concrete structures for retaining aqueous liquid.*

BS 8102: 1990 *Code of practice for protection of structures against water from the ground.*

BS 8110: *Structural use of concrete*:
Part 1: 1997 *Code of practice for design and construction.*
Part 2: 1985 *Code of practice for special circumstances.*
Amendment slip number 1: AMD 5914,
Part 3: 1985 *Design charts for singly reinforced beams, doubly reinforced beams and rectangular columns.*
Amendment slip number 1: AMD 5918.

BS 8301: 1985 *Code of practice for building drainage.*
Amendment slip number 1: AMD 5904
2: AMD 6580.

OTHER PUBLICATIONS

British Cement Association. *Basement waterproofing: Design guide.* Crowthorne, BCA, 1994. 19 pp. (Ref 48.058)

British Cement Association. *Basement waterproofing: Site guide.* Crowthorne, BCA, 1994. 21 pp. (Ref 48.059)

Building Research Establishment. *Radon: guidance on protective measures for new dwellings.* Garston, BRE, 1992. BR 211. 16pp.

Building Research Establishment. *Construction of new buildings on gas-contaminated land.* Garston, BRE, 1991. BR 212. 6pp.

1997

BRITISH CEMENT ASSOCIATION
Century House
Telford Avenue
Crowthorne
Berks
RG45 6YS
Tel: 01344 762676
Fax: 01344 761214

NATIONAL HOUSE-BUILDING COUNCIL
Buildmark House
Chiltern Avenue
Amersham
Bucks
HP6 5AP
Tel: 01494 434477
Fax: 01494 728521