

Structural design of low rise buildings —

Part 2: Code of practice for masonry walls for housing

ICS 91.040.30; 91.060.10

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee, B/525, Building and civil engineering structure, to Subcommittee B/525/6, Use of masonry, upon which the following bodies were represented:

- Aluminium Federation
- Association of Consulting Engineers
- British Cement Association
- British Constructional Steelwork Association Ltd.
- British Masonry Society
- Construction Confederation
- Construction Products Association
- Department of Transport
- Federation of Civil Engineering Contractors
- Health and Safety Executive
- Institution of Civil Engineers
- Institution of Structural Engineers
- Office of the Deputy Prime Minister (Building Regulations Division)
- Royal Institute of British Architects
- Royal Institution of Chartered Surveyors (Building Control Forum)
- Standing Committee on Structural Safety
- Timber Research and Development Association

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

- Association of Building Engineers
- Autoclaved Aerated Concrete Products Association
- Brick Development Association
- British Ceramic Research Ltd.
- British Precast Concrete Federation Ltd.
- Concrete Block Association
- Department of the Environment for Northern Ireland
- Institute of Building Control
- Mortar Industries Association
- NHBC (National House-Building Council)
- Scottish Office

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 14 March 2005

© BSI 14 March 2005

First published January 1996
Second edition March 2005

Amendments issued since publication

Amd. No.	Date	Comments

The following BSI references relate to the work on this British Standard:
Committee reference B/525/6
Draft for comment 04/30104570 DC

ISBN 0 580 45463 0

Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Field of application	3
5 Materials and components	11
6 Conditions relating to walls	12
Annex A (normative) External walls of small single storey non-residential buildings and annexes	26
Annex B (informative) Design provisions for movement in masonry	31
Bibliography	33
Figure 1 — Field of application	3
Figure 2 — Walls with a difference in ground level on opposite sides	5
Figure 3 — Map of United Kingdom showing basic wind speed (in m/s)	6
Figure 4 — Zones of significant topography	7
Figure 5 — Calculation procedure for maximum building height	7
Figure 6 — Maximum height of building	8
Figure 7 — Measuring storey and wall heights	9
Figure 8 — Maximum floor areas enclosed by structural walls	10
Figure 9 — Building size and shape	10
Figure 10 — Minimum wall thickness for external and separating walls	12
Figure 11 — Minimum wall thickness for external and separating walls with storey heights <i>A</i> and <i>D</i>	13
Figure 12 — Compressive strength of masonry units for buildings	14
Figure 13 — Lintel spanning in the plane of the wall	16
Figure 14 — Plan of lintel spanning at right angles to the wall	16
Figure 15 — Spacing of wall ties	18
Figure 16 — Internal buttressing walls	20
Figure 17 — Piers and chimneys providing restraint	21
Figure 18 — Size and position of openings and recesses	22
Figure 19 — Sizes of chases	23
Figure 20 — Sizes of chimneys	24
Figure 21 — Sizes of parapet walls — Maximum height 860 mm	25
Figure A.1 — Size and shape of buildings or annexes	27
Figure A.2 — Location of openings	28
Figure A.3 — Wall thicknesses	29
Figure A.4 — Horizontal lateral restraint at roof level	30
Figure B.1 — Movement joint at change in external wall height	31
Figure B.2 — Offsets	32
Figure B.3 — Movement joints in terraced housing	32
Table 1 — Factor <i>T</i>	8
Table 2 — Factor <i>A</i>	8
Table 3 — Maximum allowable building height in metres	8
Table 4 — British Standards for materials and components	11
Table 5 — Compressive strengths of bricks and blocks used in Figure 12 (in N/mm ²)	15
Table 6 — Normalized compressive masonry unit strengths of clay and calcium silicate blocks to BS EN 771-1 and -2	15
Table 7 — Minimum bearing length for lintels	17
Table 8 — Selection of lengths of wall ties	19
Table 9 — Selection of strengths of wall ties	19
Table 10 — Value of <i>X</i> in Figure 18	23

Foreword

This part of BS 8103 has been prepared under the direction of Technical Committee B/525. It supersedes BS 8103-2:1996, which will be withdrawn after a period of co-existence.

A large proportion of the national building programme is concerned with new housing and alterations in both the public and private sectors where traditional methods of construction are used for the majority of houses, and it is to these that this code is applicable.

BS 8103 is published in four parts:

- *Part 1: Code of practice for stability, site investigation, foundations and ground floor slabs for housing;*
- *Part 2: Code of practice for masonry walls for housing;*
- *Part 3: Code of practice for timber floors and roofs for housing;*
- *Part 4: Code of practice for concrete suspended floors for housing.*

This code is written for those with expertise in building construction but not necessarily in structural engineering design. Low-rise buildings constructed within the limitations stated in the relevant clauses will not require additional specialist advice. For any conditions outside the limitations of this code, appropriate specialist advice is needed. It ought not be expected that the recommendations made in this part can be proved by calculation as they are based on traditional prescriptive guidance substantiated by long experience.

In formulating the guidance of this code, the worst combination of circumstances likely to arise was taken into account. It might be appropriate to consider a minor departure from the recommendations of this part and show adequacy by calculation. However, in cases where the recommendations of Clause 6 for conditions relating to a wall are not able to be met or are inappropriate then reference should be made to BS 5628-1:1992.

When using this code it is important to assess that the overall stability of the building is achieved, and that the work of any specialist engaged is properly co-ordinated. BS 8103-1 covers the stability aspect of low-rise housing.

The recommendations in this code are intended to provide economic safe designs without the need for calculations of loading and strength criteria.

The figures in this code support the text. They do not show all constructional details and are not intended to illustrate compliance with any other requirements or recommendations. They are not necessarily to scale and should not be used as working details.

This revision of the code takes into account the introduction of the new harmonized product specifications for masonry units. There will be a co-existence period (during which, both BS 8103-2:1996 and BS 8103-2:2005 will be valid), after which the new specifications will supersede the existing British Standards. This code also includes the revised wind map for the United Kingdom and revised building height tables based on the basic wind speeds defined in BS 6399-2:1997.

This code is also generally aligned with the revised Building Regulations 2004 — Approved Document A¹⁾.

The guidance in Approved Document A and this code is based on traditional simple design, within the scope of this document. The outputs are safe but not necessarily comparable with solutions derived from calculation-based design.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 33 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

¹⁾ The Building Regulations 2004 — Structure — Approved document A (issued by the Office of the Deputy Prime Minister). The document may be freely downloaded as an Acrobat file at <http://www.safety.odpm.gov.uk/bregs/brad02.htm>.

1 Scope

This part of BS 8103 gives recommendations for walls above ground level damp-proof course (DPC) and walls between ground floor level and top of foundation level in the following range of buildings of traditional construction:

- a) low-rise housing comprising detached, semi-detached and terraced houses and flats (with not more than four self-contained dwelling units per floor accessible from one staircase) of not more than three storeys above ground, intended for domestic occupation and as governed by stated limiting conditions given in this code;
- b) certain small single storey non-residential buildings, e.g. domestic garages and annexes to residential buildings not exceeding 36 m² in floor area (see Annex A). For such buildings all clauses of the code are applicable except for 4.3, 4.4a), 6.1, 6.7.3 and 6.8.

For the purposes of this code, additional habitable accommodation in the roof space constitutes a storey of the house. This code does not include the design of basements, but providing the basement is of one level only and is designed to provide a firm platform at ground level, the provisions of this code may apply to the superstructure above the basement.

The structural design recommendations described in this code are not intended to cover other considerations such as fire resistance, thermal and sound insulation, resistance to damp penetration and durability for which reference should be made, e.g. to BS 5628-3.

Proprietary housing systems and houses of timber, steel or concrete framed constructions are not covered by this code.

NOTE Annex B gives guidance on design provisions for movement.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 4729, *Specification for dimensions of bricks of special shapes and sizes*²⁾.

BS 5628-1, *Code of practice for the use of masonry — Part 1: Structural use of unreinforced masonry*.

BS 5628-3, *Code of practice for the use of masonry — Part 3: Materials and components, design and workmanship*.

BS 6100 (all parts), *Glossary of building and civil engineering terms*.

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

BS 6399-2:1997, *Loading for buildings — Part 2: Code of practice for wind loads*.

BS 8103-1:1995, *Structural design of low-rise buildings — Part 1: Code of practice for stability, site investigation, foundations and ground floor slabs for housing*.

BS 8103-3, *Structural design of low-rise buildings — Part 3: Code of practice for timber floors and roofs*.

BS 8103-4, *Structural design of low-rise buildings — Part 4: Code of practice for concrete suspended floors for housing*.

BS EN 771-1, *Specification for masonry units — Part 1: Clay masonry units*.

BS EN 771-2, *Specification for masonry units — Part 2: Calcium silicate masonry units*.

BS EN 771-3, *Specification for masonry units — Part 3: Aggregate concrete masonry units*.

BS EN 771-4, *Specification for masonry units — Part 4: Autoclaved aerated concrete masonry units*.

BS EN 771-5, *Specification for masonry units — Part 5: Manufactured stone masonry units*.

BS EN 771-6, *Specification for masonry units — Part 6: Natural stone masonry units*.

BS EN 772-1, *Methods of test for masonry units — Part 1: Determination of compressive strength*.

²⁾ A revision of BS 4729 is in preparation, with provisional title *Dimensions of bricks (including those of special shape) — Recommendations*. Regardless of the title, reference should be made to the most recent version of this standard.

BS EN 845-1, *Specification for ancillary components for masonry — Part 1: Ties, tension straps, hangers and brackets*.

BS EN 998-2:2003, *Specification for mortar for masonry — Part 2: Masonry mortar*.

BS EN 10088:1995 (all parts), *Stainless steels*.

3 Terms and definitions

For the purposes of this British Standard, the terms and definitions in BS 6100 (all parts) apply, together with the following.

3.1

annexe

single storey adjunct to a residential building with dimensions of the adjunct not exceeding those given in Annex A

NOTE Examples are a porch, veranda, loggia, conservatory, greenhouse, garage, tool shed, fuel store, water closet, lavatory, wash-house.

3.2

traditional construction

building constructed as follows:

- a) roofs;
 - 1) timber rafter and purlin,
 - 2) timber truss and purlin,
 - 3) timber trussed rafter, or
 - 4) timber flat roof;
- b) ground floors;
 - 1) timber suspended,
 - 2) concrete ground-supported,
 - 3) concrete precast suspended, or
 - 4) concrete in situ reinforced suspended;
- c) intermediate floors;
 - 1) timber suspended, or
 - 2) concrete precast suspended; and
- d) walls of masonry construction;

where loads do not exceed those given in other parts of BS 8103

3.3

thickness

<of walls>

space allocated to masonry units taking into account their allowed dimensional deviations

NOTE In the case of non-loadbearing walls, this includes the thickness of any applied finish to the wall.

3.4

Category I masonry unit

unit with a declared compressive strength with a given confidence level

NOTE Category I is defined in BS EN 771 (Parts 1 to 5), which also gives the confidence level.

3.5

Category II masonry unit

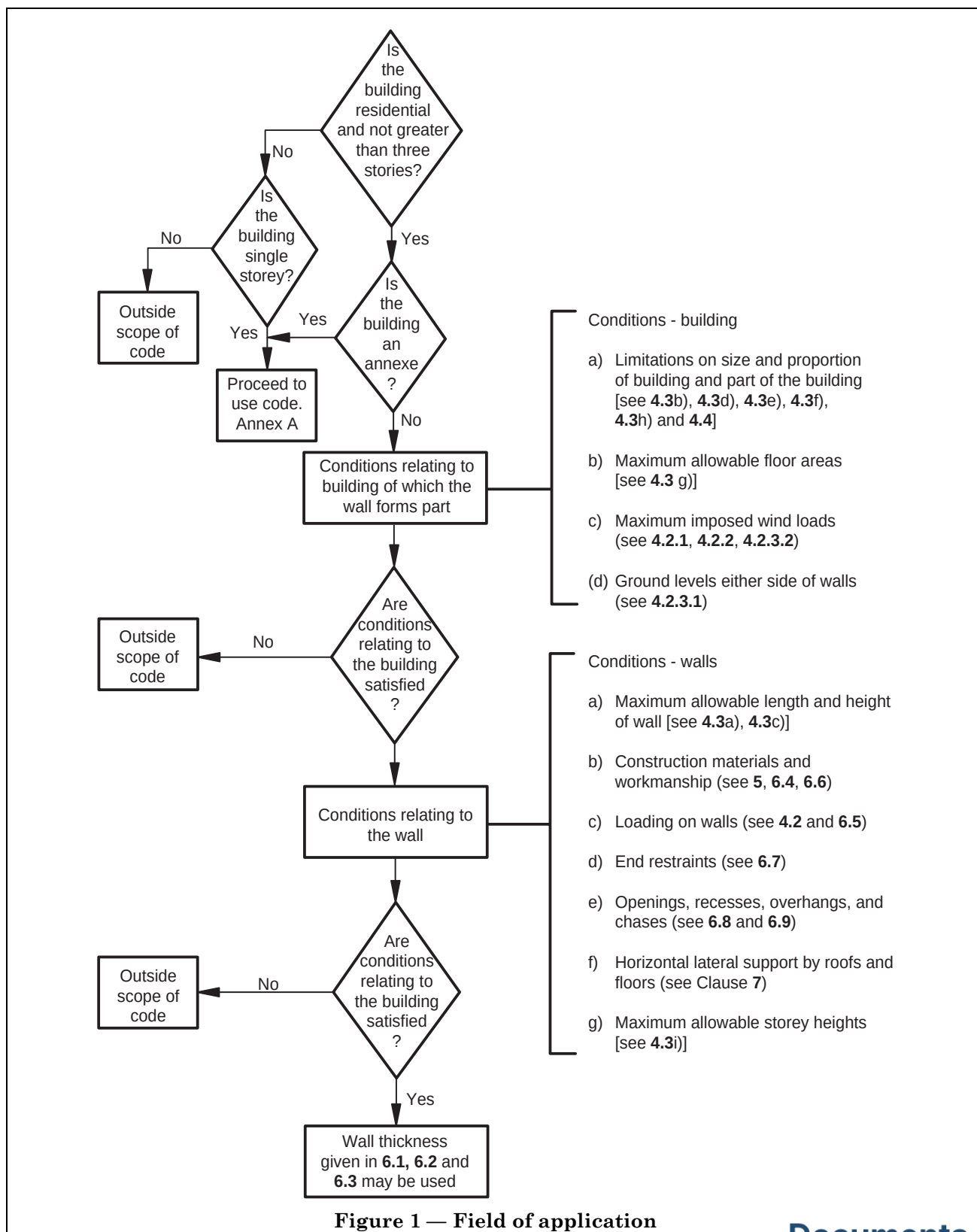
unit not intended to comply with the level of confidence of Category I units

NOTE Category II is defined in BS EN 771 (Parts 1 to 5).

4 Field of application

4.1 General

When checking whether this code applies to a particular building, reference should be made to Figure 1.



4.2 Limiting loads and dimensions

4.2.1 Vertical dead loads

All floors and roofs supported by walls conforming to this code should conform to BS 8103-3 for timber elements and BS 8103-4 for concrete floors.

4.2.2 Vertical imposed loads

The imposed loads on floors supported by walls conforming to this code, should not exceed those given in type A (domestic and residential activities) of Table 1 in BS 6399-1:1996.

4.2.3 Lateral imposed loads

4.2.3.1 Ground levels either side of walls

Where a wall is subjected to a lateral load from retained material due to a difference in ground levels on opposite sides, the difference in level above fully compacted backfill should not exceed the dimensions shown in Figure 2. The rules given in Figure 2b) do not apply where there is an adjacent roadway on the upper level, used other than by private cars, and where the roadway for such vehicles is closer than a distance equivalent to 1.25 times the retained height. Such situations are outside the scope of this code.

NOTE Figure 2 does not apply to free-standing walls.

4.2.3.2 Wind loading

The maximum wind forces to which a building is liable to be exposed vary with geographical location, the degree of exposure and the height of the building. The use of this code is based upon defined building size and shape (see 4.4), overall building height, storey height and certain other aspects (see 4.3).

It will normally be possible to establish the applicability of this code by reference to the basic wind speeds and topography zones shown in Figure 3 and Figure 4 and obtaining the maximum overall building height by reference to Figure 5 and Table 1, Table 2 and Table 3. If the proposed building falls outside the maximum overall building height allowed, a separate design check in accordance with BS 5628 using wind loadings derived from BS 6399-2:1997 should be carried out.

4.3 Dimensions

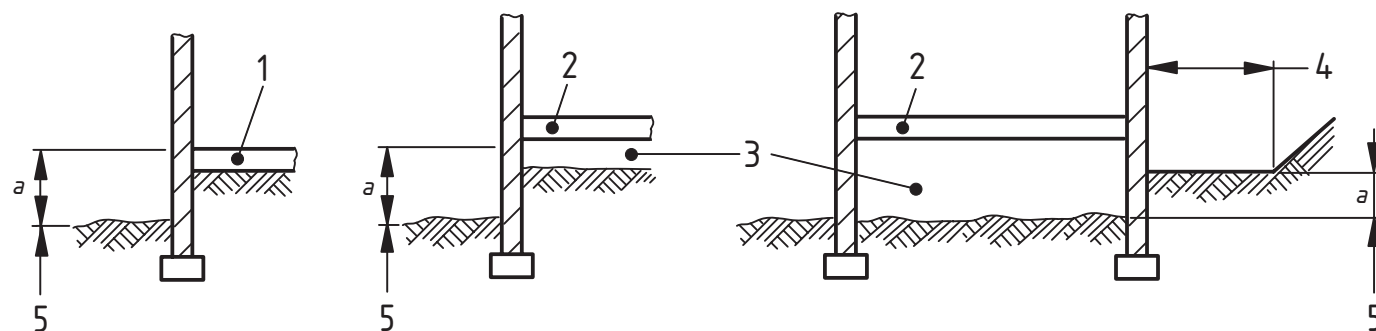
The recommendations given in this code are governed by the following limiting dimensions.

- a) The maximum length of loadbearing wall between vertical lateral supports, i.e. between centre-lines of buttressing walls, piers, return walls etc., should be 9 m (see 6.7).
- b) No part of a wall or roof should be higher than 15 m above the lowest adjacent ground level (see Figure 6).
- c) The maximum external wall height (H_1 , H_2 or H_3 , measured in accordance with Figure 7) should be 12 m.
- d) The maximum clear span of any roof should be 12 m.
- e) The maximum clear span of any floor should be 6 m.
- f) No opening in a loadbearing wall should have a clear span greater than 3 m.
- g) The maximum floor area for stability should be as shown in Figure 8.
- h) The maximum height from top of foundation to top of ground floor (see Figure 7) should be:
 - 1) 2.7 m where the floor provides lateral restraint to the wall; and
 - 2) 1 m for all other cases.
- i) For maximum storey height, see Figure 7.

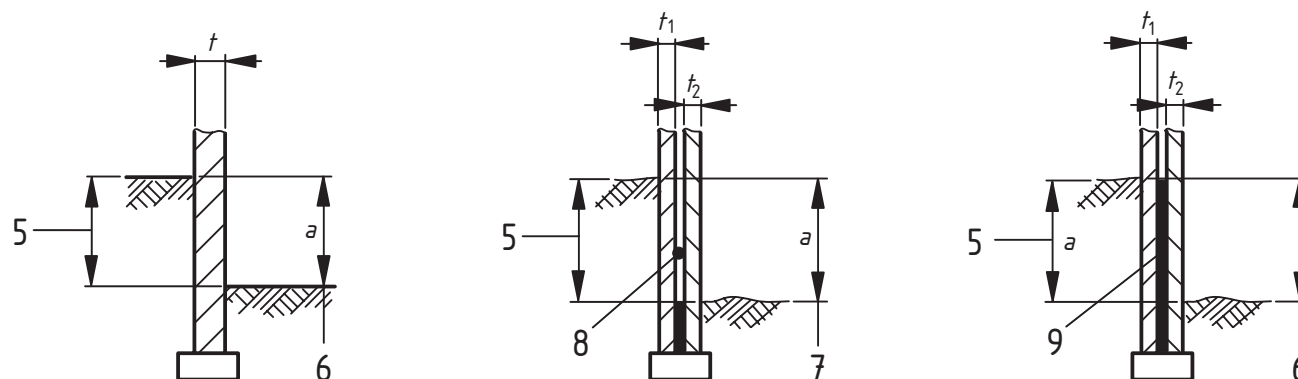
4.4 Conditions relating to the size and shape of the building of which the wall forms part

To achieve adequate stability for residential buildings of not more than three storeys against wind forces, the building dimensions, as illustrated in Figure 9, should not exceed the following values.

- a) The height of the main building (h_1) should be not greater than twice the width of the building. The width should be taken as w_1 if p_1 is equal to or less than w_3 , or as w_3 if p_1 is greater than w_3 .
- b) The width of the annexe (w_2) should be not less than half the height of the annexe (h_2) if its length (p_2) is greater than twice its width (w_2).



a) Situations where differences in level might occur



b) Maximum permitted differences in level

Key and limitations

- 1 Ground supported floor slab
- 2 Suspended ground floor
- 3 Void
- 4 To be level for a distance of not less than $1.25a$
- 5 Retained height

- 6 a should be less than or equal to one metre and less than or equal to $4t$
- 7 a should be less than or equal to one metre and less than or equal to $4(t_1 + t_2)$
- 8 Clear wall cavity (unfilled)
- 9 Concrete fill to wall cavity

NOTE 1 Cross-sectional hatching conforming to BS 8888 varies in this figure and also in Figure 10, Figure 16, Figure 17 and Figure 21 to illustrate either brickwork or blockwork. In this respect the illustrations are only typical and are not meant to exclude one or the other.

NOTE 2 Floor slabs in Figure 2b) have been omitted for clarity and may be on either side of the walls shown.

NOTE 3 Cavity walls should be tied in accordance with 6.6.

Figure 2 — Walls with a difference in ground level on opposite sides

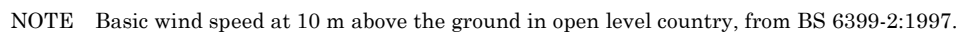


Figure 3 — Map of United Kingdom showing basic wind speed (in m/s)

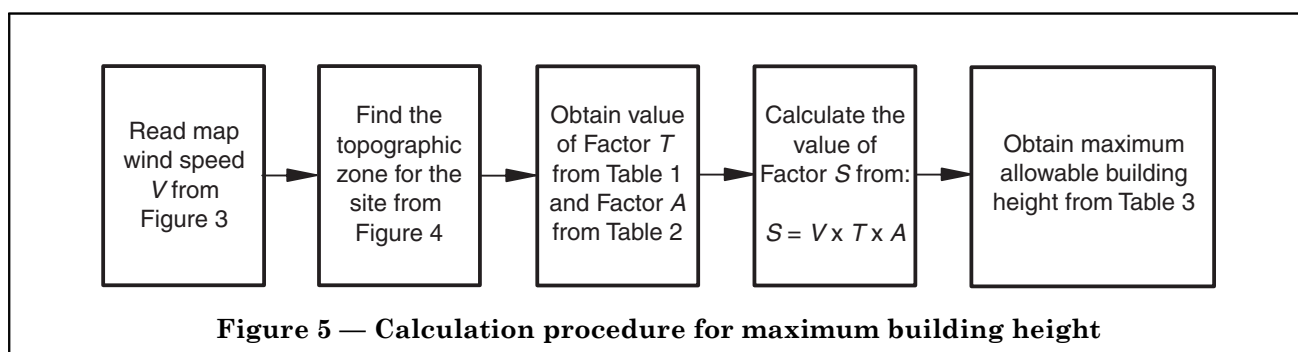
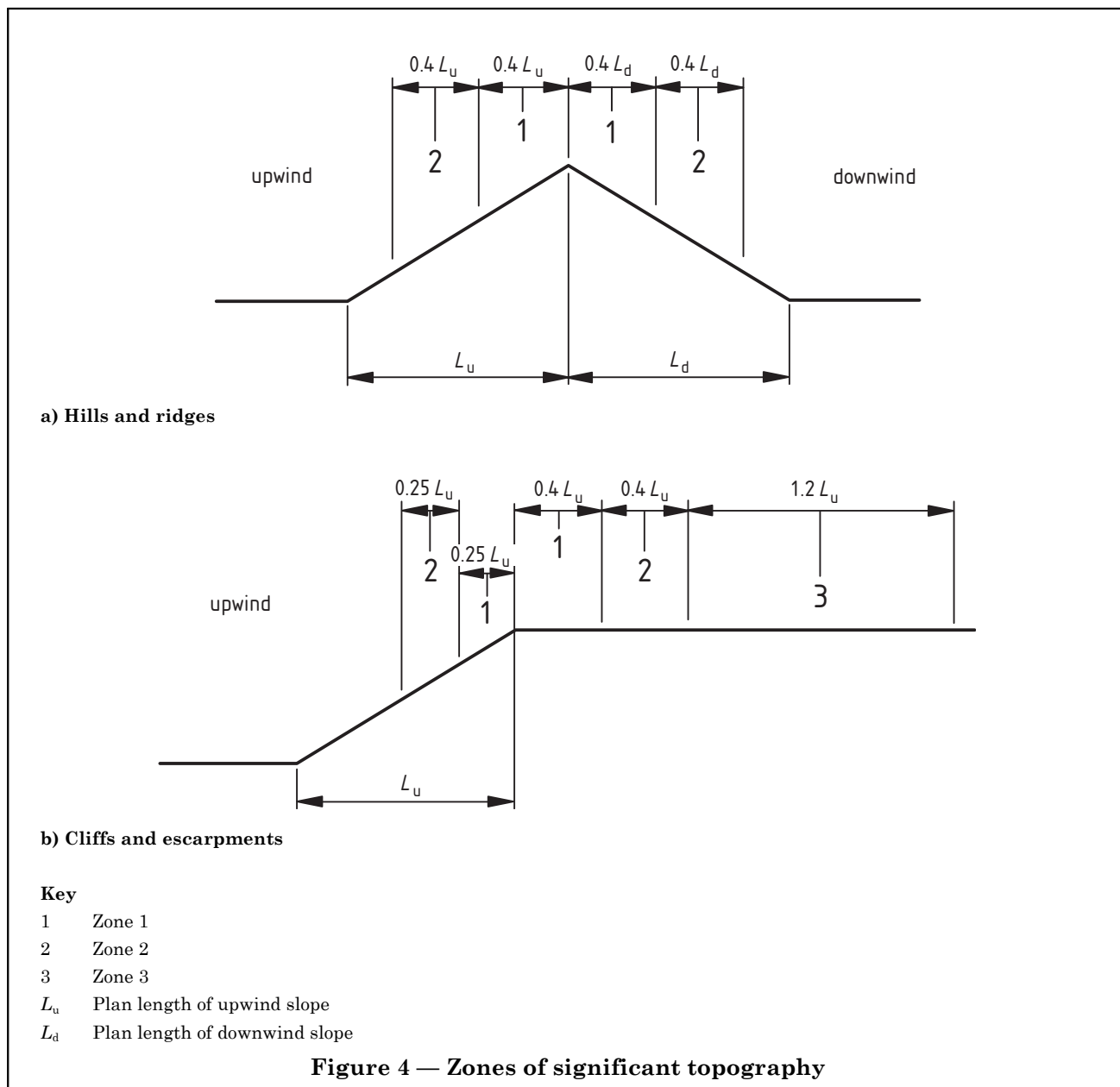


Table 1 — Factor *T*

Topographic category and average slope of whole hillside, ridge, cliff or escarpment	Factor <i>T</i>		
	Zone 1	Zone 2	Zone 3
Category 1: Nominally flat terrain, average slope <1/20	1.0	1.0	1.0
Category 2: Moderately steep terrain, average slope <1/5	1.24	1.13	1.10
Category 3: Steep terrain, average slope >1/5	1.36	1.20	1.15
NOTE Outside these zones, factor <i>T</i> = 1.0.			

Table 2 — Factor *A*

Site altitude m	Factor <i>A</i>
0	1.00
50	1.05
100	1.10
150	1.15
200	1.2
300	1.3
400	1.4

Table 3 — Maximum allowable building height in metres

Factor <i>S</i>	Country sites			Town sites ^a		
	Distance to the coast			Distance to the coast		
	<10 km	10 to 50 km	>50 km	<10 km	10 to 50 km	>50 km
24	15	15	15	15	15	15
25	11.5	14.5	15	15	15	15
26	8	10.5	13	15	15	15
27	8	8.5	10	15	15	15
28	4.5	6.5	8	13.5	15	15
29	3.5	5	6	11	13	14.5
30	3	4	5	9	11	12.5
31		3.5	4	8	9.5	10.5
32		3	3.5	7	8.5	9.5
33			3	6	7.5	8.5
34				5	7	8
35				4	6	7
36				3	5.5	6
37					4.5	5.5
38					4	5
39					3	4
40						3

^a For sites on the outskirts of towns not sheltered by other buildings, use the values for country sites.

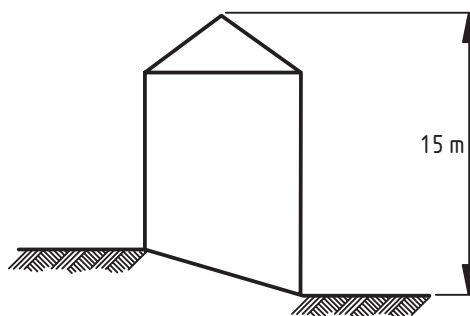


Figure 6 — Maximum height of building