BS 8103-2:2013

Incorporating Corrigendum No. 1

BSI Standards Publication

Structural design of low-rise buildings –

Part 2: Code of practice for masonry walls for housing

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Published by BSI Standards Limited 2013

ISBN 978 0 580 84979 4

ICS 91.040.30; 91.060.10

The following BSI references relate to the work on this document:
Committee reference B/525/6
Draft for comment 13/30262014 DC

Publication history

First published, January 1996
Second edition, March 2005
Third (present) edition, September 2013

Amendments issued since publication

Date	Text affected
November 2013	See Foreword

Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 40, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 8103 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 September 2013. It was prepared by Subcommittee B/525/6, *Use of masonry*, under the authority of Technical Committee B/525, *Building and civil engineering structure*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 8103 supersedes BS 8103-2:2005, which is withdrawn.

Relationship with other publications

In addition to BS 8103-2, BS 8103 comprises two further parts:

- *Part 1: Structural design of low-rise buildings. Code of practice for stability, site investigation, foundations, precast concrete floors and ground floor slabs for housing;*
- *Part 3: Code of practice for timber floors and roofs for housing.*

Information about this document

This is a full revision of the standard, and introduces the following principal changes.

- The document has been updated to bring it in line with changes to BS 8103-1.
- The wind loading map has been updated and revised.
- The references have been updated to align with the Structural Eurocodes.

A large proportion of the national building programme is concerned with new house construction or development sites and alterations, specifically house extensions and additional dwelling space. This covers 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 part of BS 8103 is applicable.

Low-rise buildings constructed in accordance with this part of BS 8103 do not require additional specialist advice. Extensions to low-rise housing also require no additional specialist advice if they, together with the original building, are constructed in accordance with this part of BS 8103. For any buildings, including those with extensions, outside the limitations of this part of BS 8103, as given in **4.2** and **4.4**, appropriate specialist advice is needed. The recommendations made in this part of BS 8103 are based on traditional prescriptive guidance substantiated by long experience of use.

In formulating the recommendations in this part of BS 8103, maximum load conditions and the most challenging limiting dimensions were used. In less challenging conditions it might be appropriate to consider a minor departure from the recommendations of this part of BS 8103 and show adequacy by calculation.

When using this part of BS 8103 it is important to assess that the overall stability of the building is achieved, and that the work of any specialist engaged is properly coordinated. BS 8103-1 covers the stability aspect of low-rise housing; by following this guidance, users comply with the general robustness requirements of BS EN 1991-1-7 and its UK National Annex.

The recommendations in this part of BS 8103 are intended to provide economic, safe designs without the need for calculations for loading and strength criteria.

The figures in this part of BS 8103 support the text. They do not show all constructional details and are not intended to illustrate compliance with any other requirements or recommendations.

Use of this document

As a code of practice, this part of BS 8103 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this part of BS 8103 is expected to be able to justify any course of action that deviates from its recommendations.

The start and finish of text introduced or altered by Corrigendum No. 1 is indicated in the text by tags [C1⟩ and ⟨C1]. Minor editorial changes are not tagged.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word "should" is used to express recommendations of this standard. The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Contractual and legal considerations

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 cannot confer immunity from legal obligations.

Particular attention is drawn to the following:

- The Building Regulations 2010 Approved Document A (Structure).
- The Scottish Building Regulations 2004. Technical Handbooks. Section 1 Structure.
- The Building Regulations of Northern Ireland 2012. Technical Booklet B.

1 Scope

This part of BS 8103 gives recommendations on the structural design 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 within the limitations (as given in **4.2** and **4.4**) of this part of BS 8103;

b) small single storey non-residential buildings, e.g. domestic garages and annexes to residential buildings not exceeding 36 m^2 in floor area (see Annex A);

*NOTE For such buildings all clauses of this part of BS 8103 are applicable except for **4.4, 4.5**a), **6.1, 6.7.3** and **6.8**.*

c) extensions to low-rise housing conforming to **1**a) providing that the extended building conforms to **4.4** and **4.5** of this part of BS 8103. If traditional masonry wall bonding (e.g. block bonding) is not used the design junction between the original building and the extension is outside the scope of this part of BS 8103-2, as is the design of any part of the original structure that is adversely affected by additional loads, including loading to foundations. The formation of new wall openings in the original building is outside the scope of this British Standard.

This British Standard is written for those with expertise in building construction but not necessarily in structural engineering design.

For the purposes of this part of BS 8103, additional habitable accommodation in the roof space constitutes a storey of the house. This part of BS 8103 does not apply to 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 part of BS 8103 may apply to the superstructure above the basement.

This part of BS 8103 does not apply to thermal and sound insulation, resistance to damp penetration and durability.

Proprietary housing systems and houses of timber, steel or concrete framed constructions are not covered by this part of BS 8103.

[C1] *Text deleted.* [C1]

2 Normative references

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

BS 4729, *Clay and calcium silicate bricks of special shapes and sizes – Recommendations*

BS 6100 (all parts), *Building and civil engineering – Vocabulary*

BS 8103-1, *Structural design of low-rise buildings – Part 1: Code of practice for stability, site investigation, foundations, precast concrete floors 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 for housing*

BS EN 771 (all parts), *Specification for masonry units*

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

BS EN 845-1, *Specification for ancillary components for masonry – Part 1: Wall ties, tension straps, hangers and brackets*

BS EN 845-3 *Specification for ancillary components for masonry – Part 3: Bed joint reinforcement of steel meshwork*

BS EN 998-2, *Specification for mortar for masonry – Part 2: Masonry mortar*

BS EN 1991-1-1, *Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight, imposed loads for buildings*

BS EN 1996-1-1, *Eurocode 6: Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures*

BS EN 1996-2, *Eurocode 6: Design of masonry structures – Part 2: Design considerations, selection of materials and execution of masonry*

BS EN 1996-3, *Eurocode 6 – Design of masonry structures – Part 3: Simplified calculation methods for unreinforced masonry structures*

NA to BS EN 1996-1-1, *UK National Annex to Eurocode 6: Design of masonry structures – Part 1-1: General rules for reinforced and unreinforced masonry structures*

PD 6678, *Guide to the specification of masonry mortar*

PD 6697:2010, *Recommendations for the design of masonry structures to BS EN 1996 1-1 and BS EN 1996-2*

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

NOTE An annexe can be a porch, veranda, loggia, conservatory, greenhouse, garage, tool shed, fuel store, water closet, lavatory, wash-house, etc.

3.2 traditional construction
building constructed as follows:

a) roofs:
   1) timber rafter and purlin;
   2) timber truss and purlin;
   3) timber trussed rafter;
   4) timber flat roof.

b) ground floors:
   1) timber suspended;
   2) concrete ground-supported;
   3) concrete precast suspended;
   4) concrete in-situ reinforced suspended.

c) intermediate floors:
   1) timber suspended;
   2) concrete precast suspended.

d) walls of masonry construction.

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 finish applied 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 (all parts), which also gives the confidence level.

[SOURCE: BS EN 771 (all parts)]

3.5 Category II masonry unit
unit not intended to conform to the level of confidence of Category I units

NOTE Category II is defined in BS EN 771 (all parts).

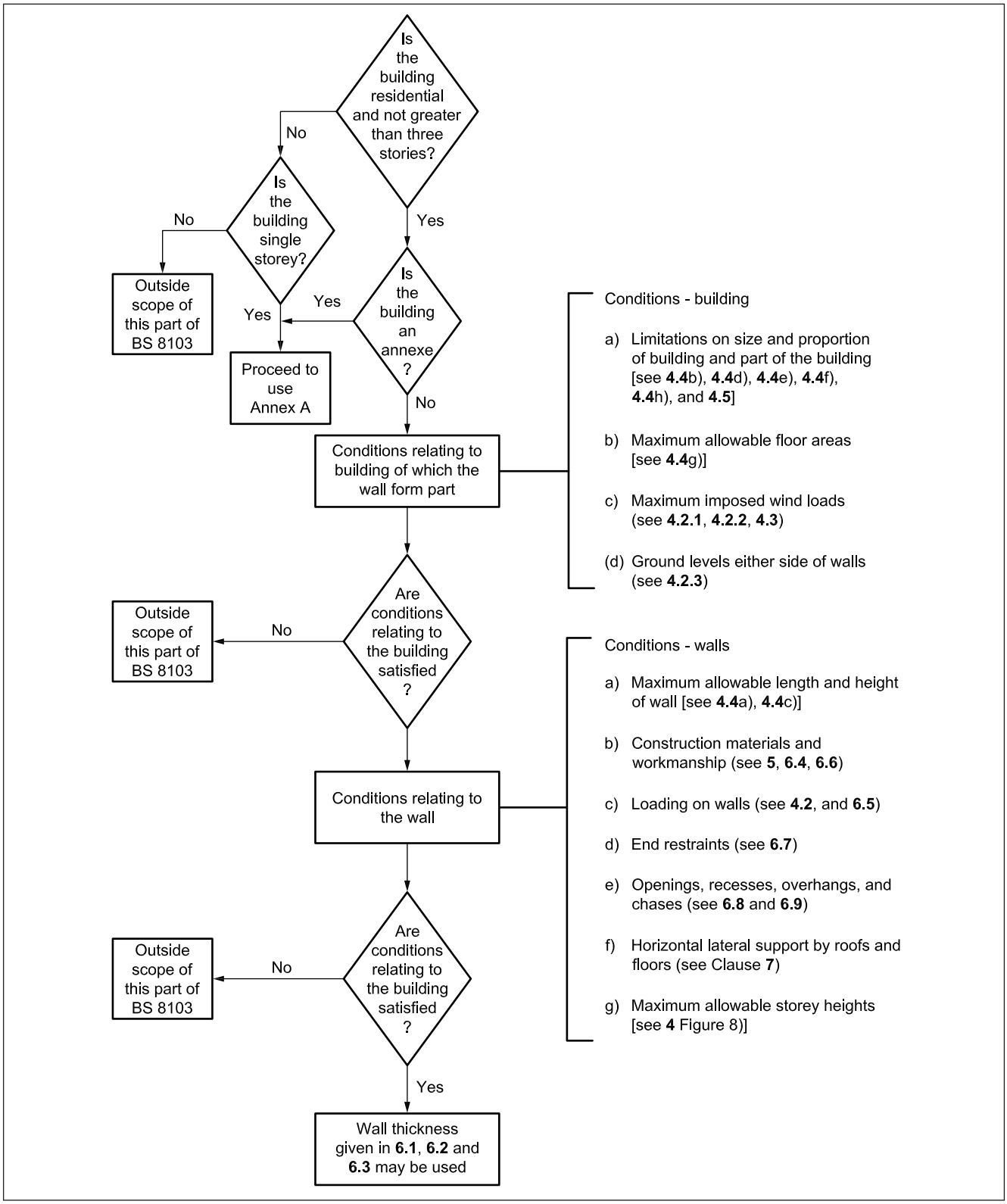
[SOURCE: BS EN 771 (all parts)]

4 Field of application

4.1 General

The field of application of this part of BS 8103 should be determined in accordance with Figure 1.

Figure 1 **Field of application**



4.2 Limiting loads and dimensions

4.2.1 Vertical dead loads

All floors and roofs supported by walls conforming to **3.2** should conform to BS 8103-1 for precast and in-situ concrete floors and BS 8103-3 for timber elements.

4.2.2 Vertical imposed loads

The imposed loads on floors supported by walls should be not greater than those given for sub-catergories A1 and A5 (domestic and residential activities) in accordance with BS EN 1991-1-1 and NA to BS EN 1991-1-1.

4.2.3 Lateral imposed loads: ground levels either side of walls

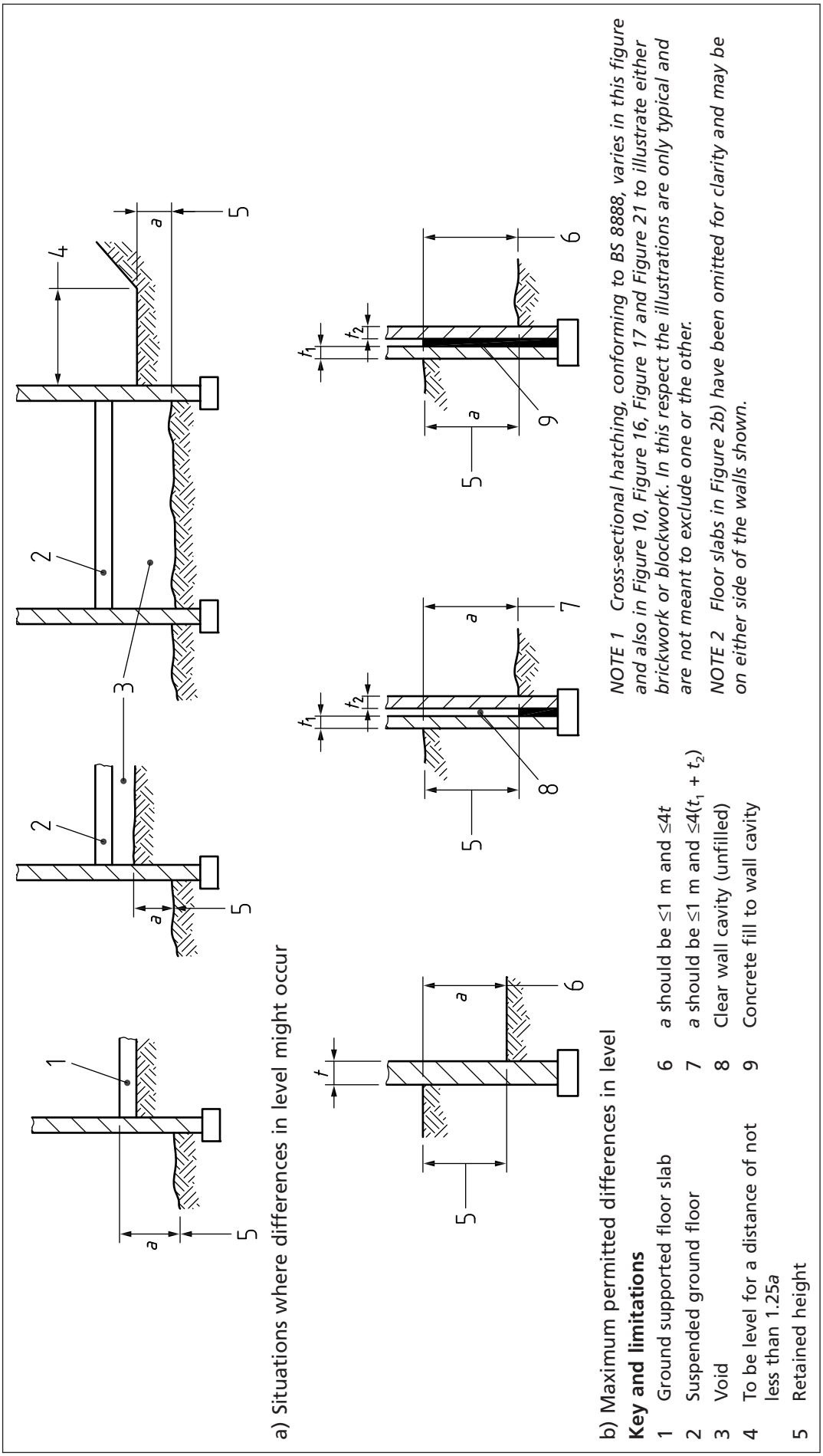
Where a wall is subjected to a lateral load from retained material due to a difference in ground levels on opposite sides, the difference in level above fully compacted backfill should be not greater than the dimensions shown in Figure 2.

Cavity walls should be tied in accordance with **6.6**.

NOTE 1 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 part of BS 8103.

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

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



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.

4.3 Wind loading

NOTE 1 The magnitude of wind pressure to which a building is exposed is dependent on its height, geographical location and degree of exposure.

The recommendations given in BS 8103-2 are valid for a dynamic wind pressure not exceeding 1.2 kN/m^2. A simplified method of checking that the dynamic wind pressure is not greater than 1.2 kN/m^2 is given in Table 1 to Table 3 and should be carried out as follows:

a) the basic wind speed, *V*, at the site of the building should be determined from the map in Figure 3;

b) the altitude factor, A, should be determined for the altitude of the site (see Table 1);

c) the orographic factor, O, should be determined: it should be 1.0 for normal level sites; for sites on hills and escarpments it should be determined in accordance with Table 2 and Figure 4 taking into account the slope of the whole hillside and the position of the building in relation to the ridge of the hill or edge of the escarpment;

NOTE 2 Alternatively, a more accurate value for factor O may be determined using Figure 5 or Figure 6.

d) calculate the value of *S* by multiplying together basic wind speed, V×A×O.

e) determine the maximum permissible height of the building from Table 3 depending on the value of S, whether the building is within a town or country location and the distance to the coast.

NOTE 3 The magnitude of wind pressure to which a building is exposed is dependent on its height, geographical location and degree of exposure. This simplified method cannot take into account all local variations and the results might differ from local experience. Where a more accurate estimate of the allowable building height is desired, appropriate advice can be sought. BS EN 1991-1-4 and NA to BS EN 1991-1-4 can be used to do this, by calculating the peak velocity pressure, qp, for the site at the desired building height of up to 15 m. If qp is ≤1.2 kN/m^2 then that building height is allowed within the scope. If qp is >1.2 kN/m^2 then incrementally reduce the building height and repeat the calculation until qp is ≤1.2 kN/m^2 this then gives the maximum allowable building height.

Table 1 **Altitude factor**

Site altitude	Factor A
m	
0	1.00
50	1.05
100	1.10
150	1.15
200	1.20
300	1.30
400	1.40
500	1.50

NOTE 1 When sites are elevated on hillsides or similar topographic features and fall within the shaded zones identified in Figure 5 and Figure 6, orography is significant and a more accurate assessment of factor A can be obtained by using the altitude of the general land level at the base of the topographic feature instead of the altitude at the site (see Figure 4).

NOTE 2 Interpolation may be used.

Table 2 **Factor O**

[C1] **Orographic category and average slope of whole hillside, ridge, cliff or escarpment** [C1]	**Factor O**		
	Zone 1	**Zone 2**	**Zone 3**
Category 1: nominally flat terrain, average slope <1/20	1.0	1.0	1.0
Category 2: shallow terrain, average slope <1/10	1.12	1.07	1.05
Category 3: moderately steep terrain, average slope <1/5	1.24	1.13	1.10
Category 4: steep terrain, average slope >1/5	1.36	1.20	1.15

NOTE Outside of the zones the factor O = 1.0.

Table 3 **Maximum allowable building height**

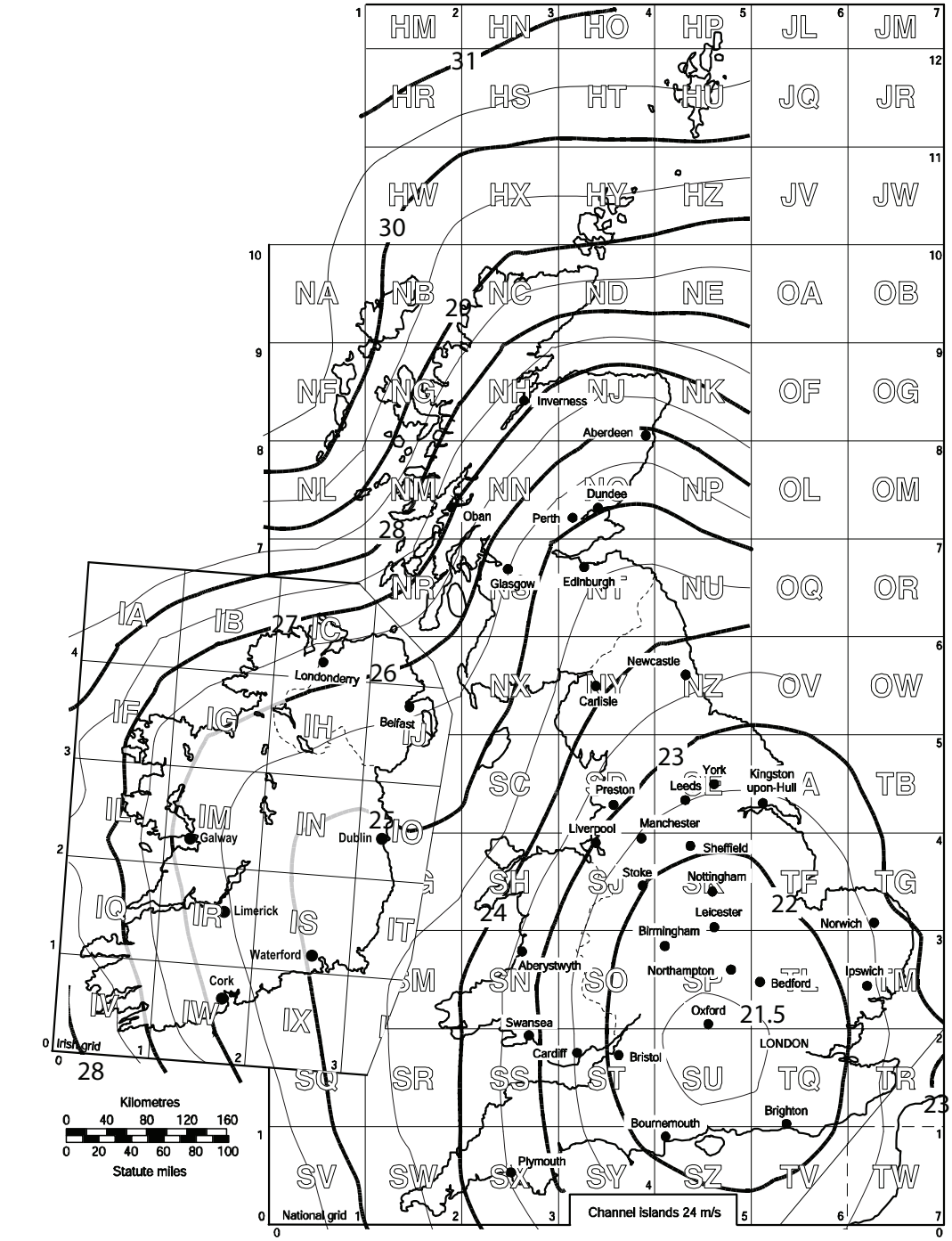
Factor S m	**Country sites**			**Town sites**		
	Distance to the coast			**Distance to the coast**		
	<2 km	2 to 20 km	>20 km	<2 km	2 to 20 km	>20 km
25 or less	15	15	15	15	15	15
26	11.5	13.5	15	15	15	15
27	8	11	14.5	15	15	15
28	5.5	8	11	15	15	15
29	4	6.5	8.5	12.5	15	15
30	3	5	6.5	10	12.5	15
31	—	4	5.5	8.5	11	13.5
32	—	3.5	4.5	7	9.5	11.5
33	—	3	3.5	6	8	10
34	—	—	3	5.5	7	8.5
35	—	—	—	4.5	6.5	7.5
36	—	—	—	4	5.5	6.5
37	—	—	—	3.5	5	6
38	—	—	—	3	4.5	5.5
39	—	—	—	—	4	5
40	—	—	—	—	3.5	4.5
41	—	—	—	—	3	4
42	—	—	—	—	—	3.5
43	—	—	—	—	—	3.5
44	—	—	—	—	—	3

NOTE 1 Sites in towns less than 300 m from the edge of the town are assumed to be in country terrain.

NOTE 2 Where a site is closer than 1 km to an inland area of water that extends more than 1 km in the wind direction, the distance to the coast is taken as <2 km.

NOTE 3 Interpolation may be used.

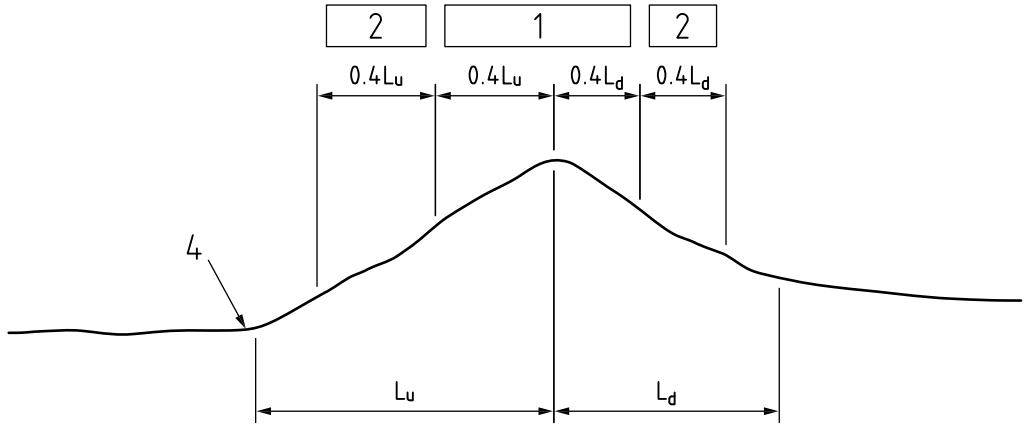
Figure 3 **Basic wind speed, V, map (m/s) before the altitude correction is applied**



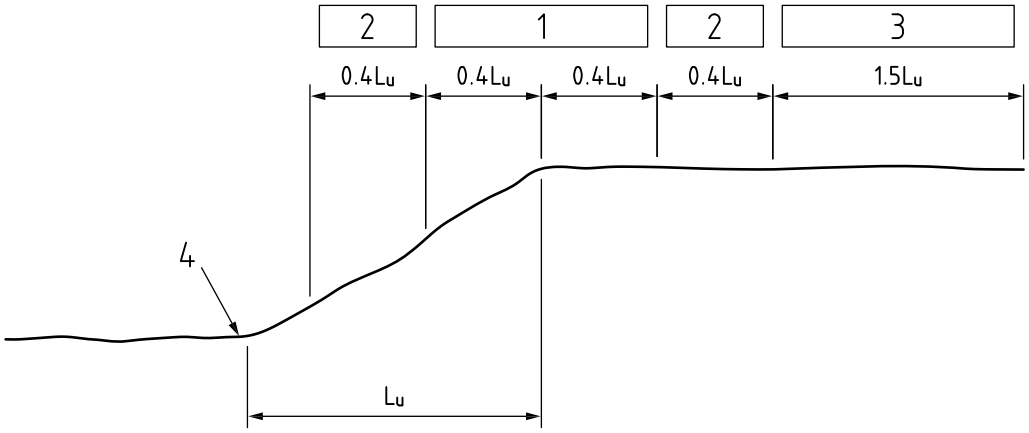
NOTE 1 This map is intended for sites in the United Kingdom, Isle of Man and Channel Islands only.

NOTE 2 The isopleths in the Irish Republic are shown for purposes of interpolation only. C1

Figure 4 **Orographic zones for factor O**



a) Orographic zones for factor O for hills and ridges

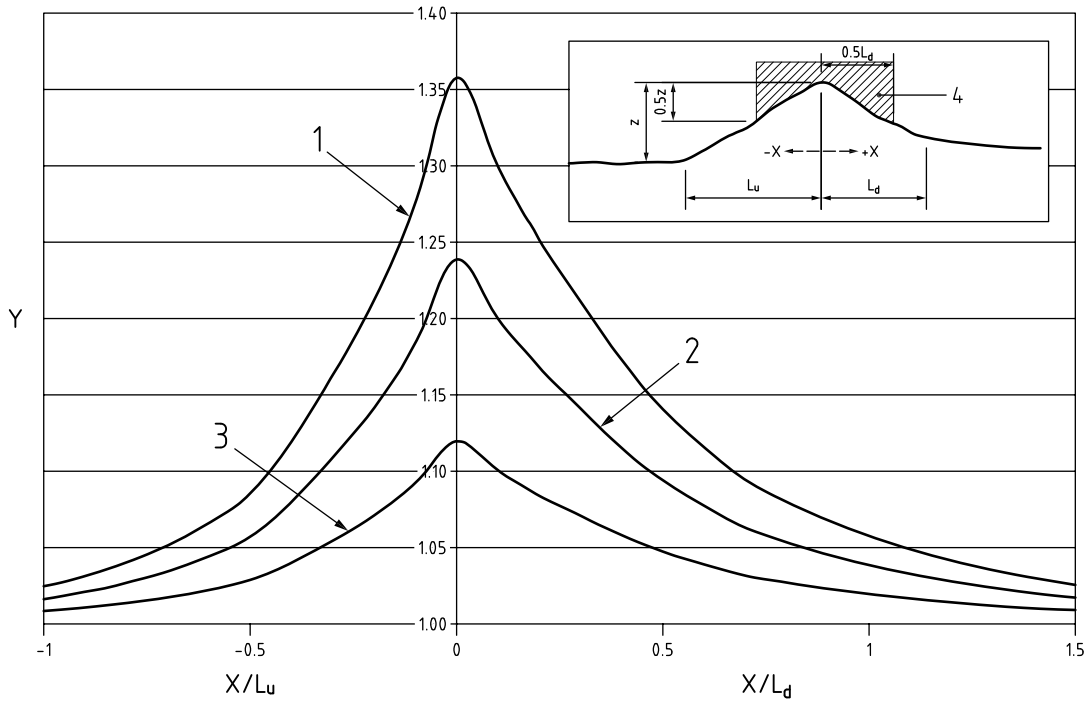


b) Orographic zones for factor O for cliffs and escarpments

Key

1 Zone 1
2 Zone 2
3 Zone 3
4 Alternative position for site altitude when orography is significant (see Table 1, Note 1)

Figure 5 **Orography factor, O, for hills and ridges**

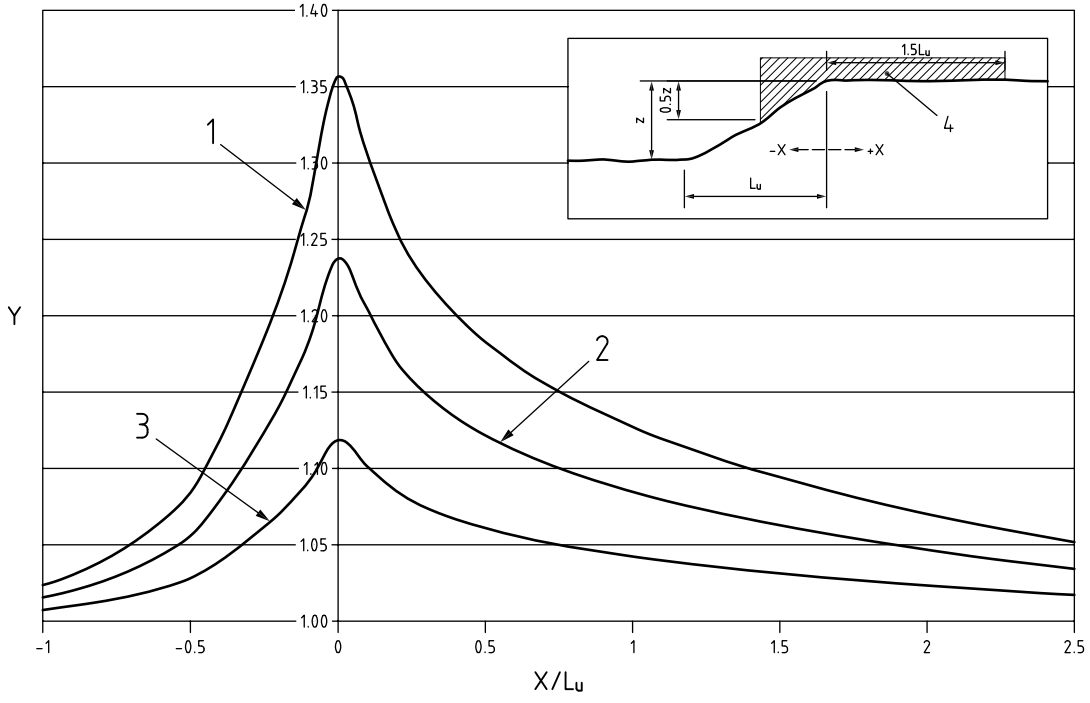


Key

1 Steep slope <1/3.3
2 Moderate slope = 1/5
3 Shallow slope ≤1/10
4 Orography significant in shaded area

NOTE Interpolation between curves may be used.

Figure 6 **Orography factor, O, for cliffs and escarpments**



Key

1 Steep slope <1/3.3
2 Moderate slope = 1/5
3 Shallow slope ≤1/10
4 Orography significant in shaded area

NOTE Interpolation between curves may be used.

4.4 Limiting dimensions of the building

For the purposes of this part of BS 8103 the following limitations should be applied.

a) The maximum length of loadbearing walls 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 7).

c) The maximum external wall height (H_1, H_2 or H_3, measured in accordance with Figure 8) 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 9.

h) The maximum height from top of foundation to top of ground floor (see Figure 8) should be:

   1) 2.7 m where the floor provides lateral restraint to the wall; and

   2) 1 m for all other cases.

i) The maximum storey height should be as shown in Figure 8.

Figure 7 **Maximum height of building**

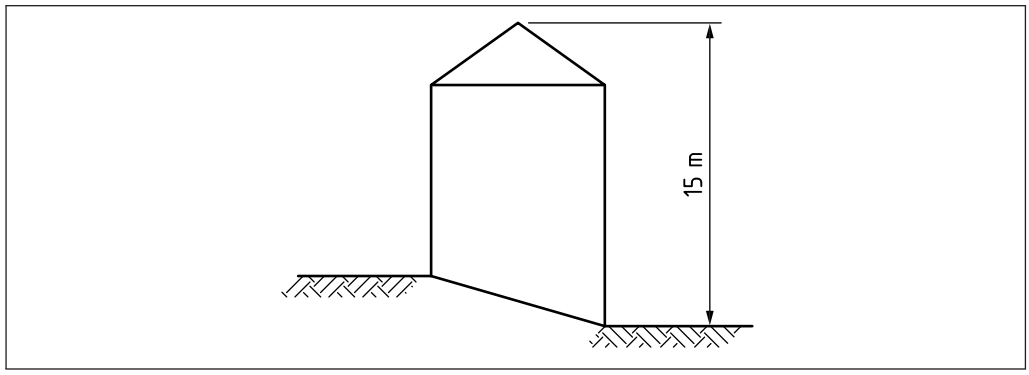
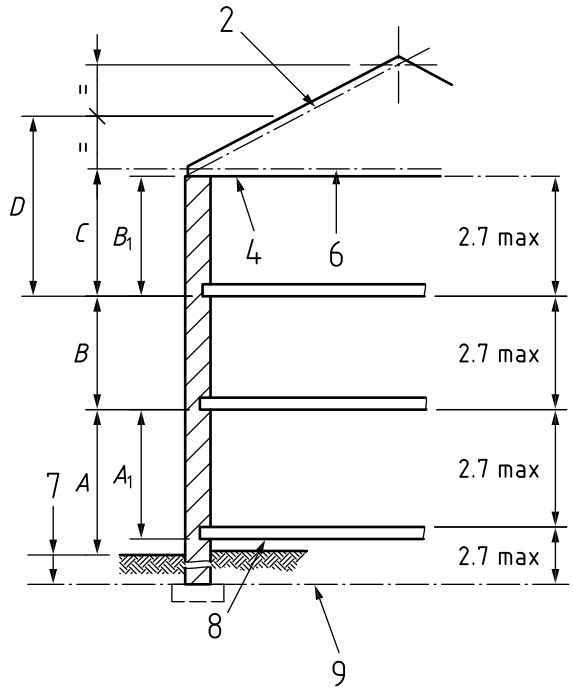
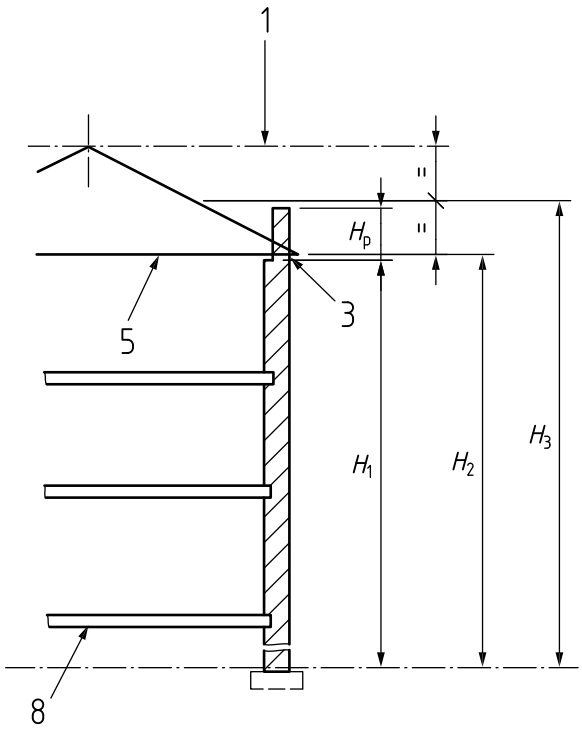


Figure 8 **Measuring storey and wall heights**

Dimensions in metres



a) Storey heights



b) Wall heights

Key

1	Line of the top gable	B	Intermediate storey height
2	Line of lateral support to gable wall along roof slope	B_1	Top storey height for walls which do not include a gable
3	Top of the wall or the base of the parapet	C	Top storey height where lateral support is given to the gable at both ceiling level and along the roof slope
4	Underside of roof joists		

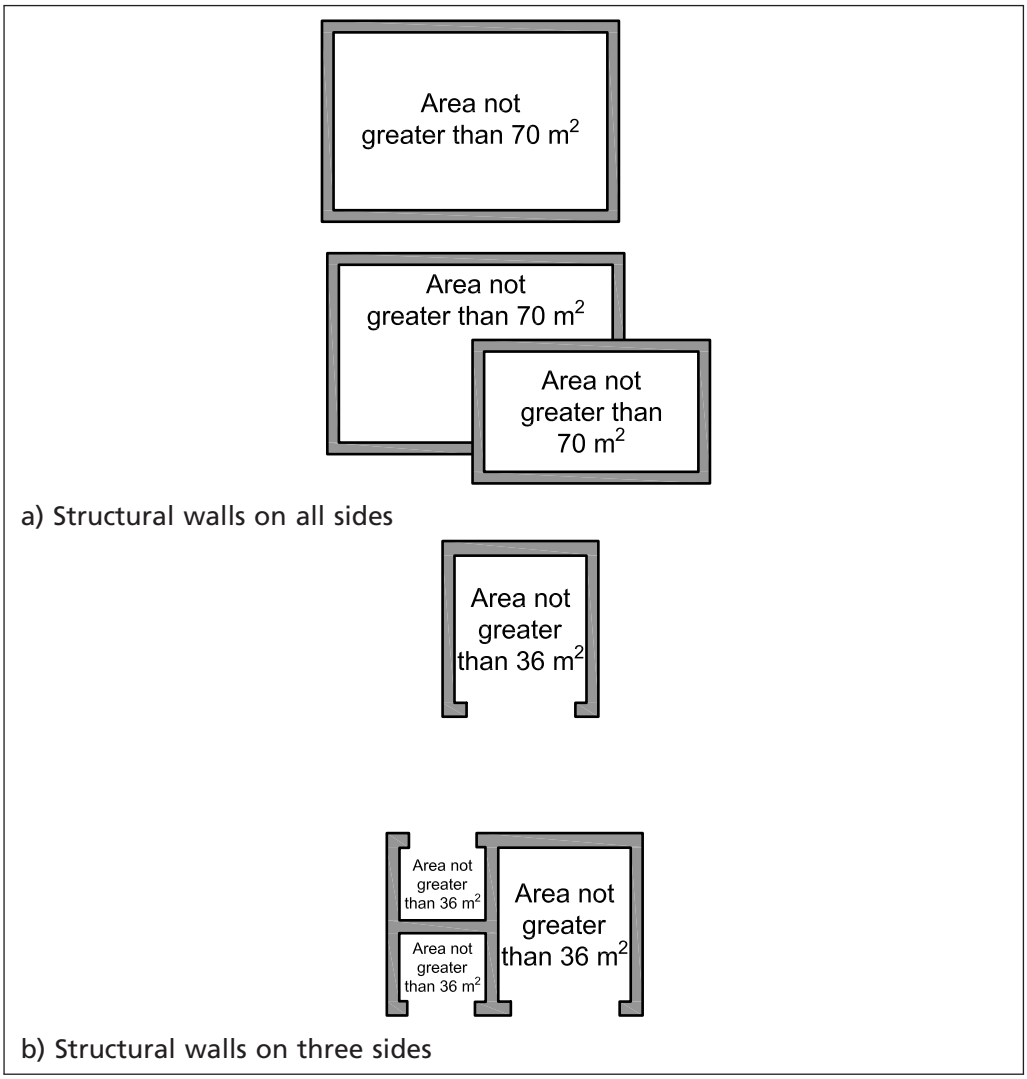
Figure 8 **Measuring storey and wall heights**

5	Line of the base of the gable
6	Line of lateral support to gable at ceiling level
7	Base of the wall [A)]
8	Ground level
9	Top of the foundation
A_1	Ground storey height if the ground floor provides effective lateral support to the wall, i.e. is adequately tied to the wall or is a suspended floor bearing on the wall
A	Ground storey height if the ground floor does not provide effective lateral support to the wall [A)]
D	Top storey height for external walls which include a gable where lateral support is given to the gable only along the roof slope
H_1	Height of an external wall that does not include a gable
H_2	Height of an internal or separating wall which is built up to the underside of the roof
H_3	Height of an external wall which includes a gable
H_p	Height of a parapet (see Figure 21). [B)]

[A)] If the wall is supported adequately and permanently on both sides by suitable compact material, the base may be taken as the lower level of this support. (Not greater than 3.7 m ground storey height.)

[B)] If H_p is more than 1.2 m add to H_1.

Figure 9 **Maximum floor areas enclosed by structural walls**



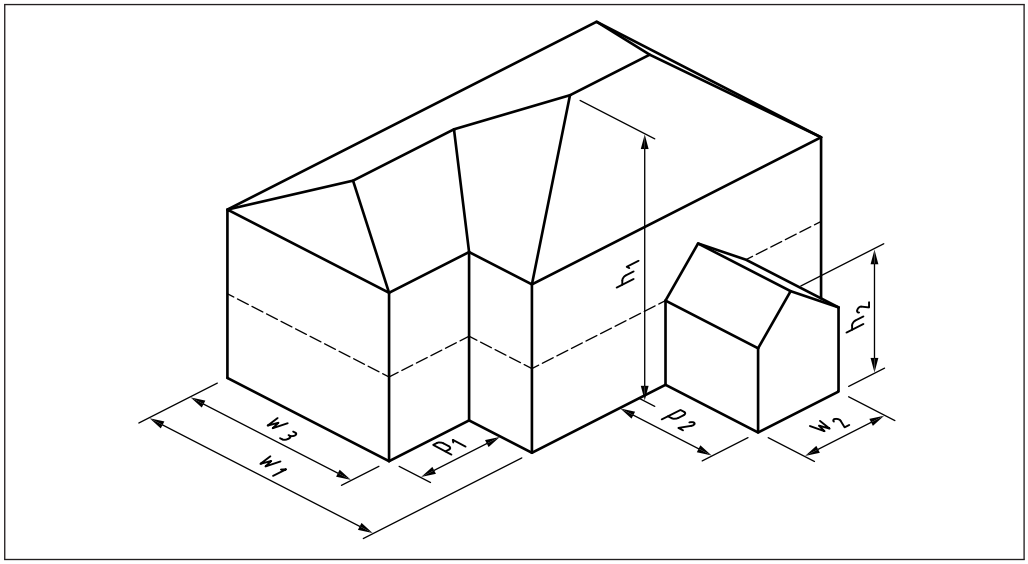
4.5 Conditions relating to the size and shape of the building of which the wall forms part

To achieve stability for residential buildings of not more than three storeys against wind forces, the building dimensions should be not greater than the set values in accordance with Figure 10.

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 an annexe (w_2) should not be less than half the height of the annexe (h_2) if its length (P_2) is greater than twice its width (w_2).

Figure 10 **Building size and shape**



4.6 Design provisions for movement in masonry

For design provisions for movement in masonry the recommendations of Annex B should be followed.

5 Construction materials of walls

Walls should be made of construction materials that conform to Table 4.

Table 4 **British Standards for construction materials**

Construction Material	British Standard to be conformed to	Other recommendations
Clay masonry units	BS EN 771-1	Compressive strength should be in accordance with Figure 13, and Table 5 and Table 6 when tested in accordance with BS EN 772-1
Calcium silicate masonry units	BS EN 771-2	
Aggregate concrete masonry units	BS EN 771-3	
Autoclaved aerated concrete masonry units	BS EN 771-4	
Manufactured stone masonry units	BS EN 771-5	
Natural stone masonry units	BS EN 771-6	—
Mortar: general purpose (ready mixed and site mixed)	BS EN 998-2 and PD 6678 [A)]	In accordance with Table 15 of PD 6697:2010 and not less than either strength class M4 or designation (iii) (1:1:5 to 6, cement:lime:sand, with or without an air entraining additive, measured by volume or mass of dry materials)
Mortar: thin layer	BS EN 998-2 and PD 6697 [B)]	Not less than strength class M4 to BS EN 998-2
Wall ties	BS EN 845-1 or PD 6697	For durability, wall ties should be made from austenitic stainless steels or plastic conforming to BS EN 845-1 material/coating references [C)] 1, 2 or 3. Alternative materials for wall ties may be used if shown to be of equivalent performance to the above.
Dimensions and shapes of bricks including those with special shapes and sizes	BS 4729	—

[A)] Guidance in selecting and specifying mortars (measured by volume or mass of dry materials for general purpose mortar) is given in PD 6678.

[B)] PD 6697, Recommendations for the design of masonry structures to BS EN 1996 1-1 and BS EN 1996-2.

[C)] Specifications for the materials/coating references are given in BS EN 845-1:2003+A1:2013, Annex A.

6 Conditions relating to walls

6.1 Thickness of walls: external and separating

In cases where the recommendations of Clause **6,** or where relevant Annex A, for conditions relating to a wall, are not able to be met or are inappropriate then reference should be made to BS EN 1996-1-1, BS EN 1996-2, BS EN 1996-3 and PD 6697:2010.

External and separating walls should have a minimum thickness conforming to Figure 11.

However, under the following circumstances of use relating to wall height, these thicknesses should be increased to the values shown in Figure 12. These situations occur for:

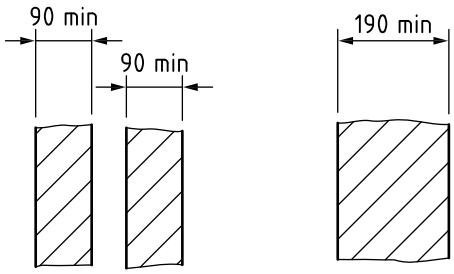
a) the ground storey height, if the ground floor does not provide effective lateral support to the wall; and

b) the top storey height, for walls which include a gable where lateral support is given to the gable only along the roof slope.

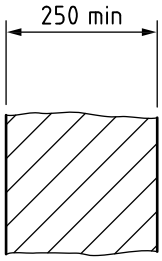
NOTE External walls of small single storey non-residential buildings and annexes are covered in Annex A.

Figure 11 **Minimum wall thickness for external and separating walls**

Dimensions in millimetres



a) Masonry units except random rubble

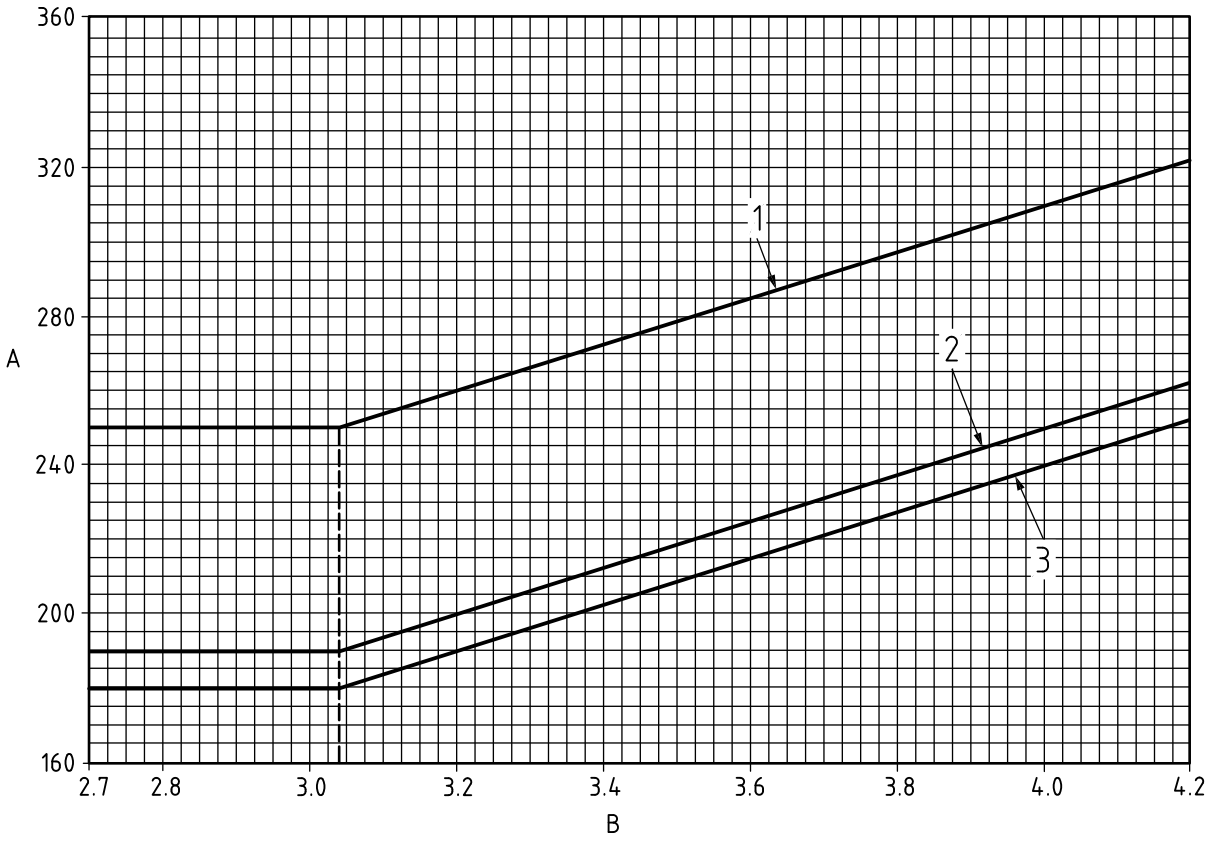


b) Random rubble

NOTE 1 Nominal cavity width of not less than 50 mm.

*NOTE 2 See **6.6** for recommendations on wall ties.*

Figure 12 **Minimum wall thickness for external and separating walls with storey heights A and D (see Figure 8)**



Key

A Minimum wall thickness required, millimetres
B Storey height, metres
1 Solid wall of random rubble
2 Single leaf walls (except random rubble)
3 Sum of leaves of a cavity wall (except random rubble)

6.2 Thickness of internal non-loadbearing masonry walls

Internal non-loadbearing masonry walls should have a thickness of not less than 75 mm (including plaster finish, but excluding dry lining) and should be adequately restrained at the head.

6.3 Thickness of internal loadbearing masonry walls (see Figure 13)

Internal loadbearing walls should have a thickness of not less than 90 mm. For two or three storey buildings the wall thickness should be either not less than 140 mm in blockwork or 215 mm in brickwork where the wall supports either:

a) two upper storeys and is greater than 1 m in height; or

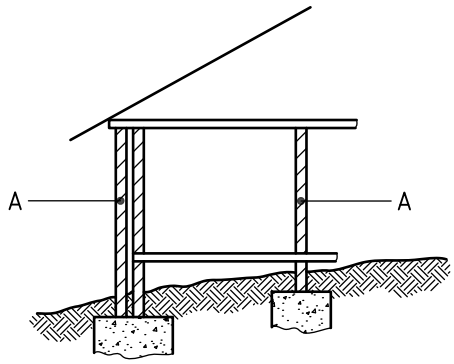
b) three storeys.

6.4 Compressive strength of masonry units

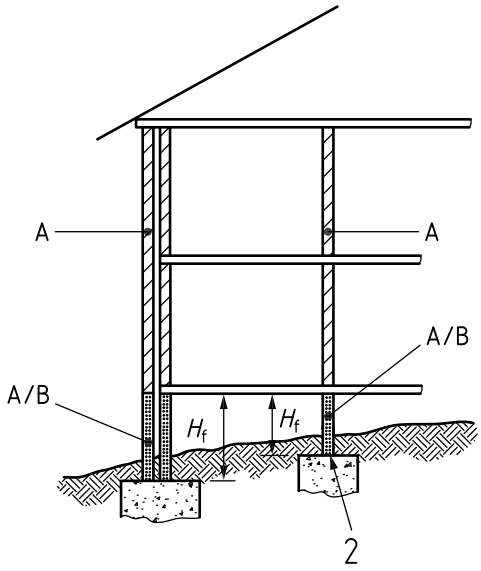
Masonry units should conform to Table 4 and should have a declared compressive strength of not less than the appropriate value given in Table 5 related to Figure 13, or a normalized compressive strength of not less than the appropriate value given in Table 6 related to Figure 13.

If the external wall is of solid construction, the masonry units should have a compressive strength at least equal to that shown for the inner leaf of a cavity wall in the same position, in accordance with Figure 13.

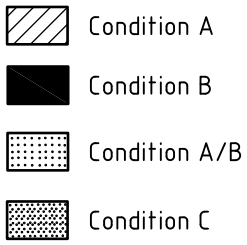
Figure 13 **Compressive strength of masonry units for buildings**

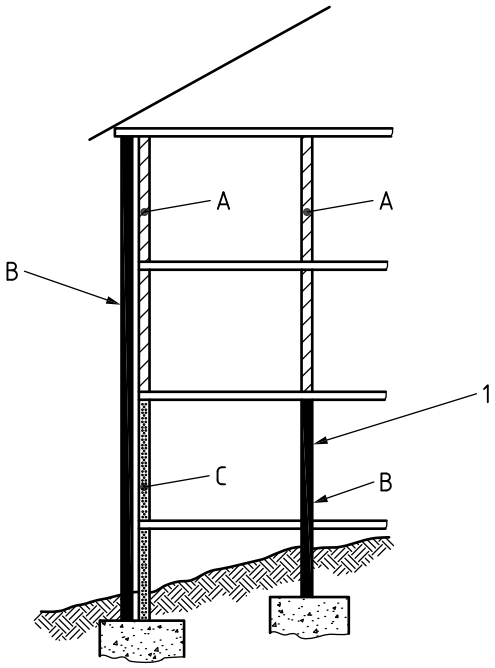


a) Single storey



b) Two storeys





c) Three storeys

Key (See also Table 5 and Table 6)

1 This wall to be not less than 140 mm thick in blockwork or 215 mm thick in brickwork.

2 This wall to be not less than 140 mm thick in blockwork or 215 mm thick in brickwork below ground floor level if height H_f exceeds 1 m.

Table 5 **Compressive strengths of bricks and blocks used in Figure 13 (in N/mm²)**

Masonry unit [A), B)]	Clay masonry units conforming to BS EN 771-1		Calcium silicate units conforming to BS EN 771-2		Aggregate concrete masonry units conforming to BS EN 771-3	Autoclaved aerated concrete masonry units conforming to BS EN 771-4	Manufactured stone masonry units conforming to BS EN 771-5
Condition A[C)]							
Brick	Group 1	Group 2	Group 1	Group 2	6	—	[D)]
	6	9	6	9			
Block	See Table 6		See Table 6		2.9	2.9 [E)]	[D)]
Condition B [C)]							
Brick	Group 1	Group 2	Group 1	Group 2	9	—	[D)]
	9	13	9	13			
Block	See Table 6		See Table 6		7.3	7.3	[D)]
Condition C [C)]							
Brick	Group 1	Group 2	Group 1	Group 2	18	—	[D)]
	18	25	18	25			
Block	See Table 6		See Table 6		7.3	7.3	[D)]

[A)] All masonry units are Category I or Category II, as defined in BS EN 771 (all parts).

[B)] For blocks with smaller bed heights, excluding cuts or make-up units, the strength requirements are as for brick except for solid external walls where the blocks should have a compressive strength greater than or equal to that shown for blocks for an inner leaf of a cavity wall in the same position.

[C)] For the shaded portions as A/B in Figure 13 where H_f is less than or equal to 1 m then A of this table should be applied and where H_f is greater than 1 m then B of this table should apply.

[D)] Any unit that conforms to BS EN 771-5 is acceptable for conditions A, B and C.

[E)] If the external wall is of solid construction of at least 300 mm thickness, the autoclaved aerated concrete masonry units can have a reduced compressive strength of 2.0 N/mm².

NOTE 1 The values given in this table are the mean compressive strengths (N/mm²) measured in accordance with BS EN 772-1 and declared in accordance with the relevant parts of BS EN 771 as given in each column.

NOTE 2 Where Group 1 and Group 2 masonry units are referred to in this table, Group 1 masonry units have not more than 25% of formed voids (20% for frogged units) and Group 2 masonry units have formed voids exceeding 25%, but not more than 55%.

NOTE 3 A brick is a masonry unit having work sizes not exceeding 337.5 mm in length or 112.5 mm in height. A block is a masonry unit exceeding either of the limiting work sizes of a brick and with a minimum bed height of 190 mm.

Table 6 **Normalized compressive masonry unit strengths of clay and calcium silicate blocks conforming to BS EN 771-1 and BS EN 771-2**

Conditions	Group 1 masonry units N/mm²	Group 2 masonry units N/mm²
A	5	8
B	7.5	11
C	15	21

NOTE 1 This table applies to clay and calcium silicate block masonry units where the work size exceeds 337.5 mm in length or 112.5 mm in height.

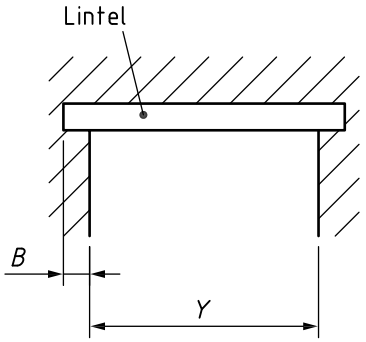
NOTE 2 Group 1 masonry units have no more than 25% of formed voids (20% for frogged units) and Group 2 masonry units have formed voids greater than 25% and less than 55%.

6.5 Lintel bearings

Supported leaves should not overhang lintels by more than 10 mm.

The length of bearing for lintels (see Figure 14 and Figure 15) should be not less than the limiting dimensions given in Table 7.

Figure 14 **Lintel spanning in the plane of the wall**

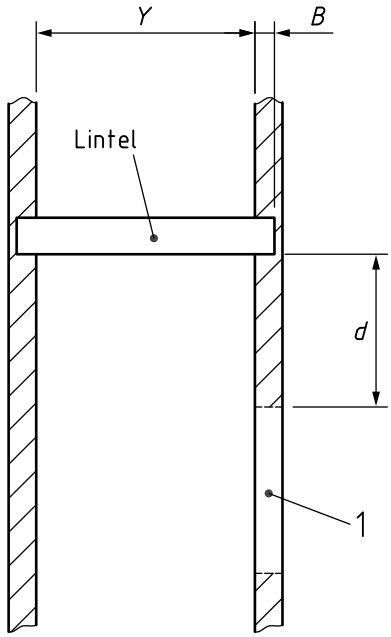


Key

B Length of bearing

Y Clear span

Figure 15 **Plan of lintel spanning at right angles to the wall**



Key

1 Opening

B Length of bearing

d Distance from edge of lintel to opening

Y Clear span

Table 7 **Minimum bearing length for lintels**

Condition	Minimum length of bearing, *B* mm		
	Lintel spanning in plane of (parallel to) the supporting wall (see Figure 14)	Lintel spanning at right angles to the support wall (see Figure 15)	
1) Lintel not supporting a concrete floor	150 [(but see also 3)]	100	
—	—	where *d* is to be less than 200	where *d* is to be ≥200, or no openings
2) Lintel supporting a concrete floor	*Y*/10 or 150 whichever is the greater [(but see also 3)]	[C1] *Y*/10 or 150 whichever is the greater	*Y*/15 or 100 whichever is the greater [C1]
3) Thickness of supporting wall or width of lintel less than 100	Value from 1) or 2) multiplied by 100/wall thickness or 100/lintel width as appropriate [(but see also 4)]	—	
4) Where the mean strength of the unit used is 25% or more than that indicated in Figure 13 and Table 5 or Table 6	Value from 1), 2) or 3) × 0.8, but not less than 150	—	

6.6 Cavity wall ties

6.6.1 Spacing

6.6.1.1 General

The leaves of a cavity wall should be tied together by wall ties with a maximum spacing of 900 mm horizontally and 450 mm vertically (density of 2.5 ties/m^2). They should normally be in a staggered pattern (see Figure 16).

6.6.1.2 Increased tie density

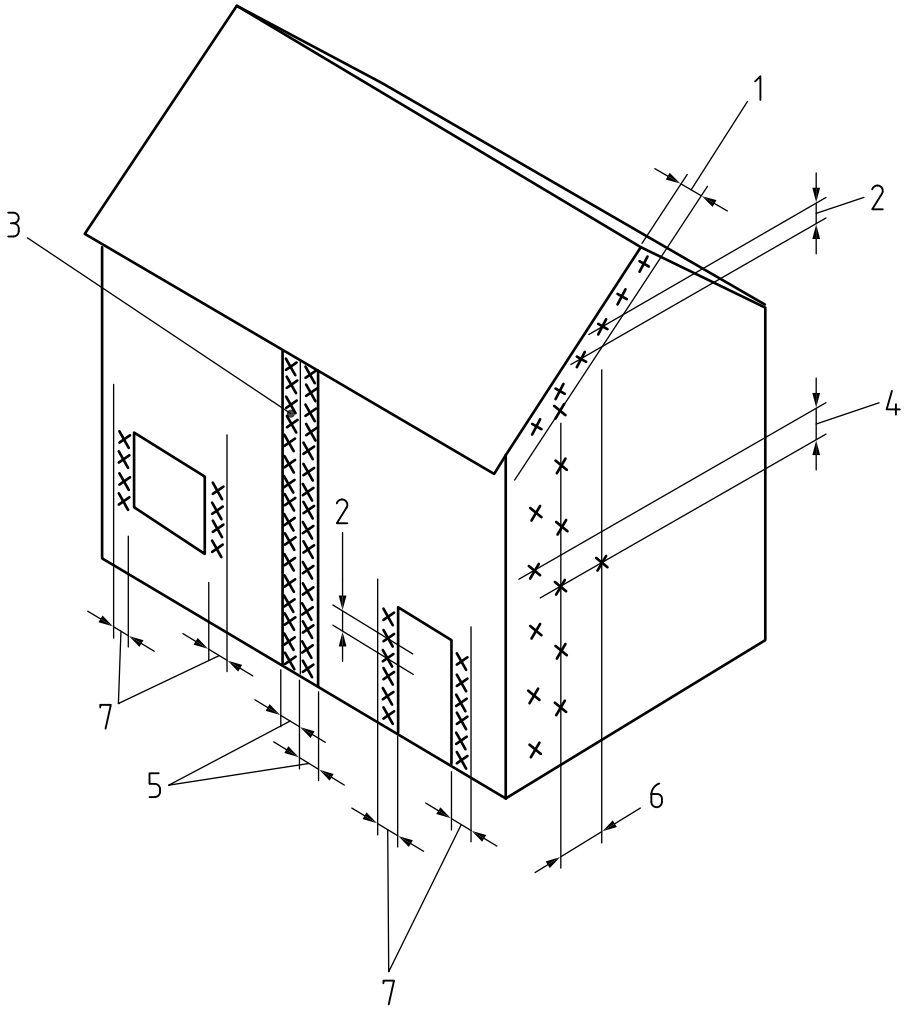
Additional ties should be provided within 225 mm of the vertical edge of all openings so that there is at least one tie for each 300 mm of height of the opening as shown in Figure 16; the following apply:

a) vertical unreturned edges should be tied as for openings;

b) sloping unreturned edges, such as the roof verge, should be tied as openings, i.e. they should be provided with at least one tie for each 300 mm of vertical height and within 225 mm of the edges;

c) the masonry adjacent to vertical movement joints in the outer leaf should be tied as for openings using ties tolerant of some horizontal movement.

Figure 16 **Spacing of wall ties**



Key

1 Maximum distance from roof verge: 225 mm
2 Maximum vertical spacing at roof verge and at the sides of openings: 300 mm
3 Movement joint
4 Maximum vertical spacing over main area: 450 mm
5 Maximum distance from movement joint: 225 mm
6 Maximum horizontal spacing: 900 mm
7 Maximum distance from the edge of openings: 225 mm

6.6.2 Length

6.6.2.1 Embedment length

The leaves of a cavity wall should be tied together by wall ties embedded into each leaf. The actual embedment length used should be not less than 50 mm for wall ties with declared design embedment lengths less than or equal to 50 mm.

For wall ties having a declared design embedment length of greater than 50 mm, the actual embedment length should be not less than the declared design embedment length. Wall ties with declared design embedment lengths greater than 50 mm should only be used if they do not project from either masonry walling leaf while still satisfying this condition.

6.6.3 Overall length

The length of ties should be in accordance with Table 8.

Table 8 **Selection of lengths of wall ties**

Minimum leaf thickness (one or both) mm	Nominal cavity width mm	Wall ties conforming to BS EN 845-1 (see Table 4)	Tie length [A] mm
90	75 or less	Types 1 to 4 conforming to PD 6697:2010 should be selected on the basis of design (see Table 9) and design cavity width	200
90	76 to 100		225
90	101 to 125		250
90	126 to 150		275
90	151 to 175		300
90	176 to 300		[B]

[A] This column gives tie lengths in 25 mm increments, for the embedment length of not less than 50 mm in both leaves, after taking into account all building and material tolerances, but that also the ties should not protrude from the face. Tie lengths may vary if it can be proven by design

[B] For cavities wider than 175 mm and for 50 mm tie embedment depth, calculate the tie length as the sum of the nominal cavity width plus 125 mm and select the nearest stock length.

All wall ties should be placed with an embedment length in accordance with the manufacturer's recommendations and be not less than 50 mm.

6.6.4 Strength

The declared strengths of wall ties appropriate to the cavity width and strength of masonry units and mortar used should be not less than the values given in Table 9 for the corresponding storey height.

6.6.5 Stiffness

Tie types should be selected which are adequately stiff to transmit axial loads but sufficiently flexible to allow some relative movement of the two leaves.

Table 9 **Selection of strengths of wall ties**

Storey height of walls m	Wall tie Type to PD6697:2010
Up to 2.7	Types 1 to 4
Greater than 2.7	Type 1 or 2

6.7 Vertical lateral restraint

6.7.1 Buttressing walls, piers and chimneys

The ends of every loadbearing wall should be bonded or otherwise securely tied throughout the full height of the wall to a buttressing wall, pier or chimney.

*NOTE Long walls may be provided with intermediate buttressing support, effectively dividing the wall into distinct lengths, each length being defined as a structural wall as given in **4.4**a).*

Any buttressing wall, pier or chimney should provide support from the base to the full height of the supported wall (see Figure 17).

6.7.2 Internal buttressing walls providing restraint

The buttressing wall should be bonded or securely tied to the wall, or loadbearing leaf of a cavity wall, that it is supporting. The other end of the buttressing wall should also be bonded or securely tied to a buttressing wall, pier or chimney.

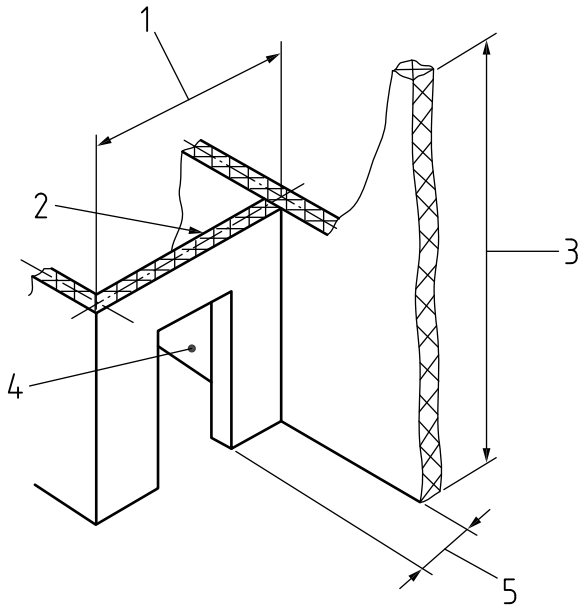
NOTE In the case of a connection between a loadbearing wall on foundations and a non-loadbearing wall supported on a ground-bearing slab, it is preferable to tie, not bond, the walls to reduce the risk of cracking due to differential vertical movement.

The position and size of openings or recesses in a buttressing wall should not impair the vertical support that is being provided by the buttressing wall (see Figure 17).

The length of the buttressing wall should be not less than 1/6 of the overall height of the supported wall (see Figure 17).

In dwelling houses, a non-loadbearing masonry wall should be used as a buttressing wall to provide support to other walls. The thickness of such a wall should be not less than 75 mm if the supported wall does not, as a whole, exceed 6 m in height or 9 m in length. In all other cases, the thickness of a buttressing wall should be not less than 90 mm.

Figure 17 **Internal buttressing walls**



Key

1 The length of the buttressing wall
2 Buttressing wall
3 Height of supported wall (see Figure 8)
4 The opening height should be not more than 0.9 times the floor to ceiling height, and the depth of the lintel including any masonry over the opening should be not less than 150 mm
5 An opening or recess should be at least 550 mm from the supported wall with the exception of small holes for services, etc., which should be limited to a maximum aggregate area of 0.1 m²

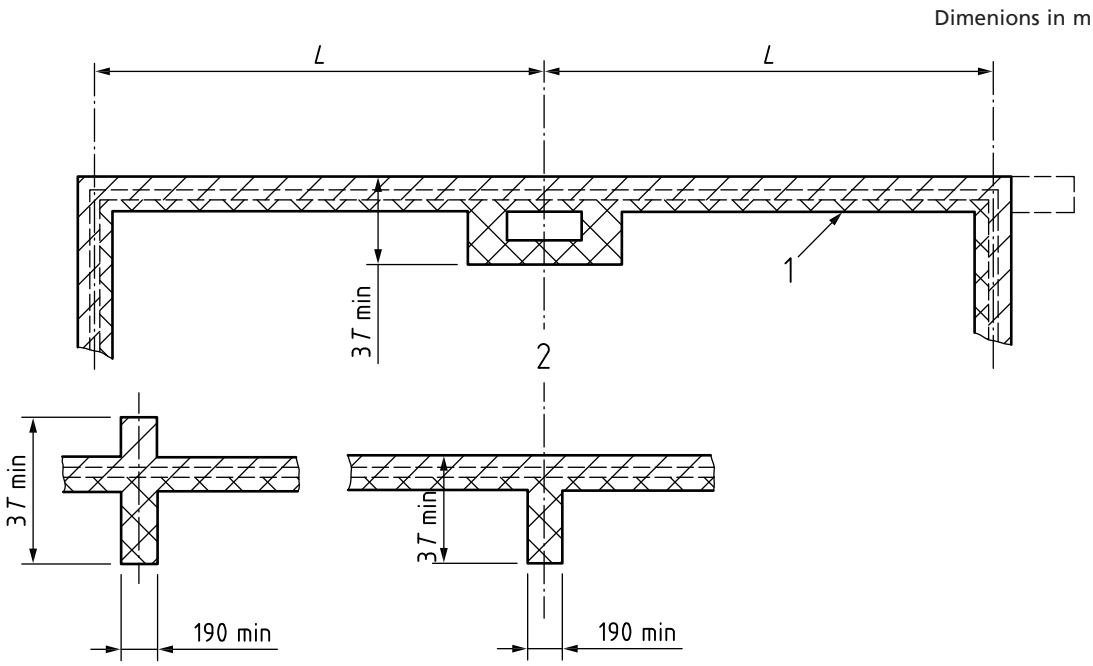
6.7.3 Piers and chimneys providing restraint

Piers should be at least three times the thickness of the supported wall, and chimneys should be at least twice the thickness of the supported wall, measured at right angles to the wall. To assess pier and chimney proportions, the wall thickness given in **6.1** should be used. Piers should have a minimum width of 190 mm (see Figure 18).

The sectional area on plans of chimneys (excluding openings for fireplaces and flues) should be not less than the area recommended for a pier in the same wall.

The buttressing pier or chimney should provide support to the full height of the wall from base to top of wall.

Figure 18 **Piers and chimneys providing restraint**



Key

1	Supported wall (cavity or solid)	*L*	Length of the wall
2	Centre line of chimney	*T*	Thickness of supported wall recommended by **6.7.3**

6.8 Limitations on size and position of openings and recesses

The number, size and position of openings and recesses should not impair the stability of a wall in which they are included or the lateral support afforded by a buttressing wall to a supported wall (see **6.7.2**).

Construction over openings and recesses should be supported with lintels or beams.

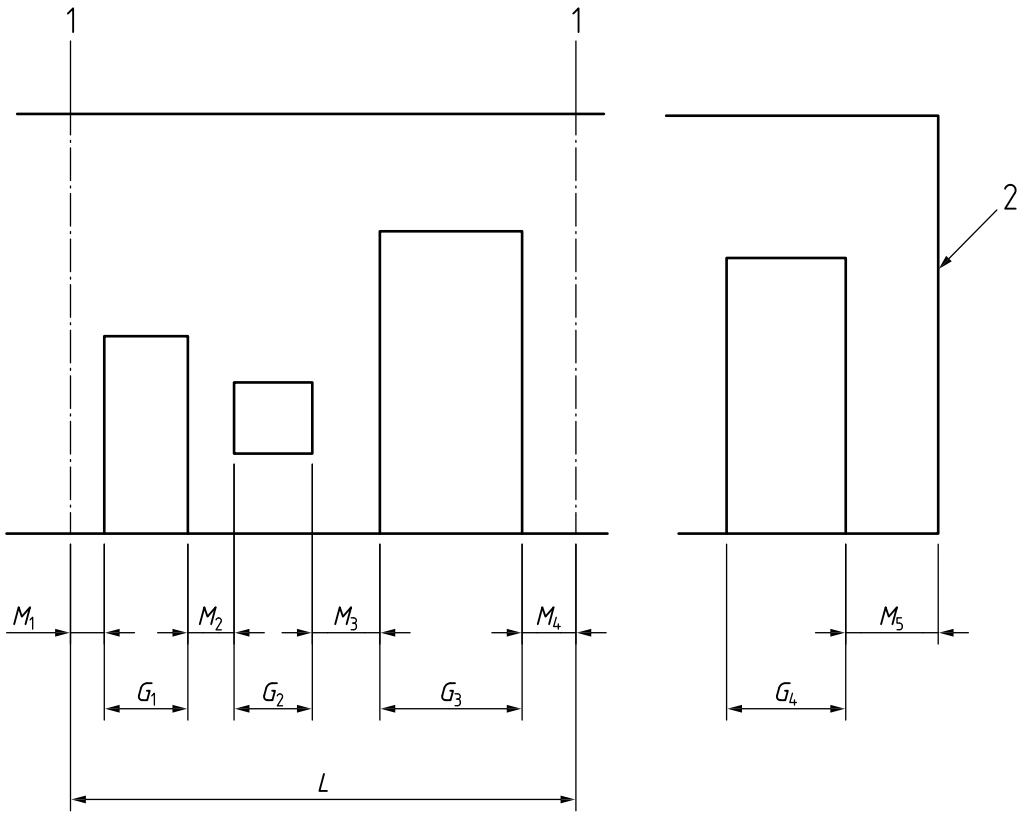
Openings and recesses above the ground floor should be positioned in accordance with Figure 19 and Table 10. Openings should be not greater than 3 m in width.

No openings should be provided in walls below ground floor level except for small holes for services and ventilation, etc., which should be limited to a maximum area of 0.1 m^2 at not less than 2 m centres.

The clear height of an individual opening should be not greater than 0.9 times the clear floor to ceiling height, and the depth of the lintel, including any masonry over the opening, should be not less than 150 mm.

The total width of openings between buttressing walls or piers should not exceed 2*L*/3. The width of any individual openings should be not greater than 3 m.

Figure 19 **Size and position of opening and recesses**



Key

1 Centreline of buttressing wall or pier

2 Outer face of return wall

L Length of wall

M_1 should be greater than or equal to $\frac{G_1}{X}$

M_2 should be greater than or equal to $\frac{G_1 + G_2}{X}$

M_3 should be greater than or equal to $\frac{G_2 + G_3}{X}$

M_4 should be greater than or equal to $\frac{G_3}{X}$

M_5 should be greater than or equal to $\frac{G_4}{X} + 150\ mm$

M_5 should not be less than either:

a) 665 mm for solid cavity walls having normal cavities not exceeding 75 mm in width; or

b) 780 mm for cavity walls greater than 75 mm in width.

NOTE The value of X is taken from Table 10. Alternatively, when the compressive strength of the bricks or blocks (in the case of a cavity wall in the loaded leaf) is not less than 7.3 N/mm², X can have the value 6.

Table 10 **Value of *X* in Figure 19**

Nature of roof span	Maximum roof span m	Minimum thickness of wall inner leaf mm	Span of floor is parallel to wall	Maximumn span of timber floor into wall		Maximum span of concrete floor into wall	
				4.5 m	6.0 m	4.5 m	6.0 m
			Value of *X*				
Roof spans parallel to wall	Not applicable	100	6	6	6	6	6
		90	6	6	6	6	5
Timber roof spans into wall	12	100	6	6	5	4	3
		90	6	4	4	3	3

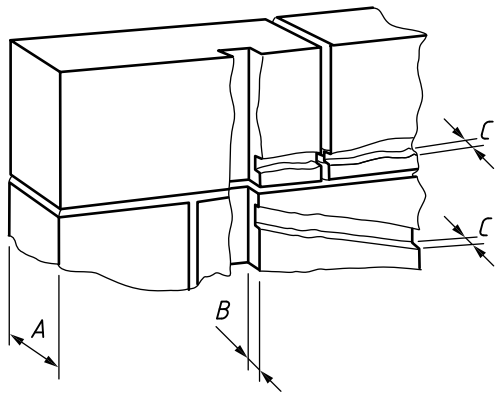
6.9 Chases

Chases should be kept to a minimum and not be positioned as to impair the stability of the wall, particularly where hollow or cellular blocks and perforated bricks are used. Where hollow blocks are used, 15 mm of block material should be retained between the back of the chase and a void or voids.

Vertical chases should be not deeper than one third of the wall thickness or, in cavity walls, one third of the thickness of the leaf (see Figure 20).

Horizontal and diagonal chases should be avoided if possible but if used should be not deeper than one sixth of the wall thickness or, in cavity walls, one sixth of the thickness of the leaf (see Figure 20).

Figure 20 **Sizes of chases**



Key

A Wall thickness

B Vertical chase

C Horizontal or diagonal chase

B should be not greater than *A*/3.

C should be not greater than *A*/6.

7 Horizontal lateral support by roof and floors

Walls in each storey of a building should extend to the full height of that storey, and have effective horizontal lateral supports to restrict movement of the wall at right angles to its plane.

Floors and roofs should:

a) be capable of transferring lateral forces from walls to buttressing walls, piers or chimneys; and

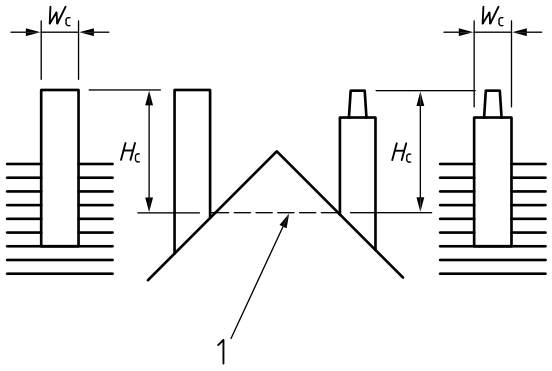
b) be secured to the supported wall by effective connections conforming to BS 8103-1.

8 Masonry chimneys

Where a chimney is not supported by the use of appropriate ties or restrained securely in any way, its height, measured from the highest point of intersection with the roof surface, gutter, etc., to the top of any chimney pot or other flue terminal, H_c, should not exceed 4.5 W_c, where W_c is the least horizontal dimension of the chimney measured at the same point of intersection (see Figure 21).

The density of masonry for chimneys should be not less than 1 500 kg/m^3.

Figure 21 **Sizes of chimneys**



Key
1 Level of highest point of intersection

9 Parapet walls

The minimum thickness and maximum height of parapet walls, for structural purposes, should be as given in Figure 22.

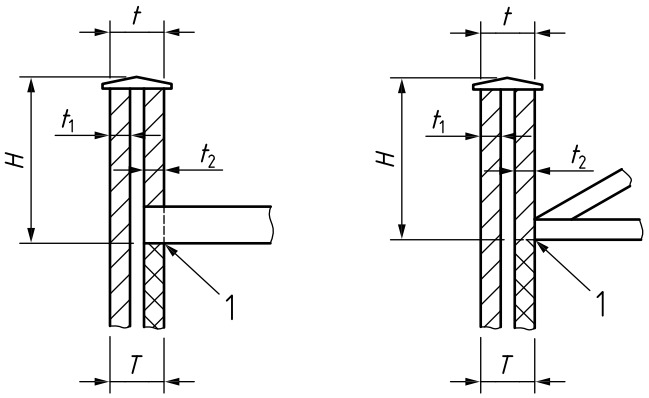
The thickness of the supporting wall *T* should be equal to or greater than the thickness *t* of the parapet wall.

Where *H* is 600 mm or less, $t_1 + t_2$ should be not less than 180 mm. Where *H* equals 860 mm, $t_1 + t_2$ should be not less than 250 mm. *H* can be interpolated between 600 mm and 860 mm, where $t_1 + t_2$ should be between 180 mm and 250 mm. For *H* less than or equal to 600 mm, *t* is greater than or equal to 150 mm. For *H* greater than 600 mm but less than or equal to 760 mm, *t* is greater than or equal to 190 mm. For *H* greater than 760 mm but less than or equal to 860 mm, *t* is greater than or equal to 215 mm.

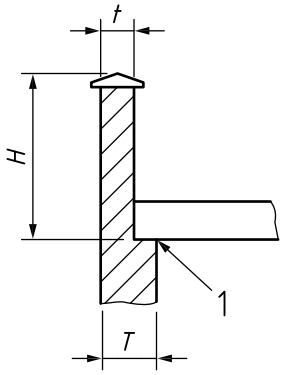
Masonry parapet walls sized by these recommendations should be used only where access is limited, e.g. for occasional maintenance. The height of parapets covered by this part of BS 8103 is limited to 860 mm.

For parapets higher than 860 mm, independent structural design is required.

Figure 22 **Sizes of parapet walls: maximum height 860 mm**



a) Cavity wall



b) Single leaf wall

Key

1 Level of junction of wall and structural roof
H Height of parapet
T Thickness of supporting wall
t Thickness of masonry parapet
t_1 Thickness of outer leaf cavity wall parapet
t_2 Thickness of inner leaf cavity wall parapet

Annex A (normative) External walls of small single storey non-residential buildings and annexes

A.1 General

The recommendations contained in this Annex apply in the following circumstances:

a) The floor area of the building or annexe should be not greater than 36 m^2.

b) The walls should be constructed in brickwork or blockwork using materials that conform to Table 4.

c) Where the floor area of the building or annexe exceeds 10 m^2, the walls should have a surface mass of not less than 130 kg/m^2.

NOTE There is no surface mass limitation recommended for floor areas of 10 m^2 or less.

d) Access to the roof should only be for the purposes of maintenance and repair.

e) The only lateral loads should be wind loads (see **4.3**).

f) The maximum length or width of the building or annexe should not be greater than 9 m.

g) The height of the building or annexe should be not greater than the lower value derived from Figure A.1 or **4.4**.

h) The roof should be braced at rafter level, horizontally at eaves level, and at the base of any gable by roof decking, rigid sarking or diagonal timber bracing, as appropriate, in accordance with BS 8103-3.

i) Walls should be tied to the roof structure vertically and horizontally in accordance with BS 8103-1 and with horizontal lateral restraint at roof level in accordance with **A.4**.

j) The roof structure of an annexe should be secured to the structure of the main building at both rafter and eaves level.

A.2 Size and location of openings

There should only be one or two major openings which should be restricted to one wall only, in accordance with Figure A.2. Their aggregate width should be not greater than 5.0 m and their height should be not greater than 2.1 m. There should be no other opening within 2.0 m of a wall containing a major opening. The aggregate size of openings in a wall not containing a major opening should not exceed 2.4 m^2. There should be not more than one opening between piers. Unless there is a corner pier the distance from a window or door opening to a corner should be not less than 390 mm.

A.3 Wall thickness and recommendations for piers

The walls should have a minimum thickness of 90 mm.

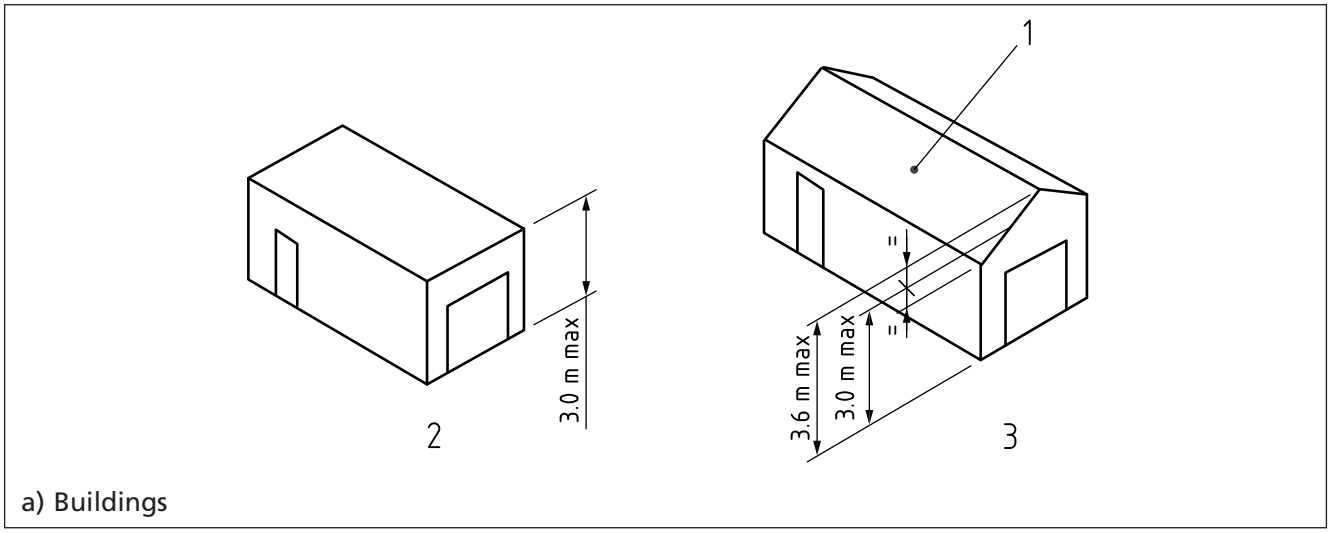
Walls that do not contain a major opening but are greater than 2.5 m in length or height should be bonded or tied to piers for their full height at not more than 3 m centres as shown in Figure A.3a). Walls which contain one or two major openings should in addition have piers as shown in Figure A.3b) and Figure A.3c). Where ties are used to connect piers to walls, they should be flat, (20 × 3) mm in cross section, be made of durable metal, be placed in pairs and be spaced at not more than 300 mm centres vertically.

A.4 Horizontal lateral restraint at roof level

Walls should be tied horizontally at no more than 2 m centres to the roof structure at eaves level, base of gables and along roof slopes with straps fixed in accordance with BS 8103-1. Where straps cannot pass through a wall they should be secured to the masonry using suitable fixings. Isolated columns should also be tied to the roof structure (see Figure A.4).

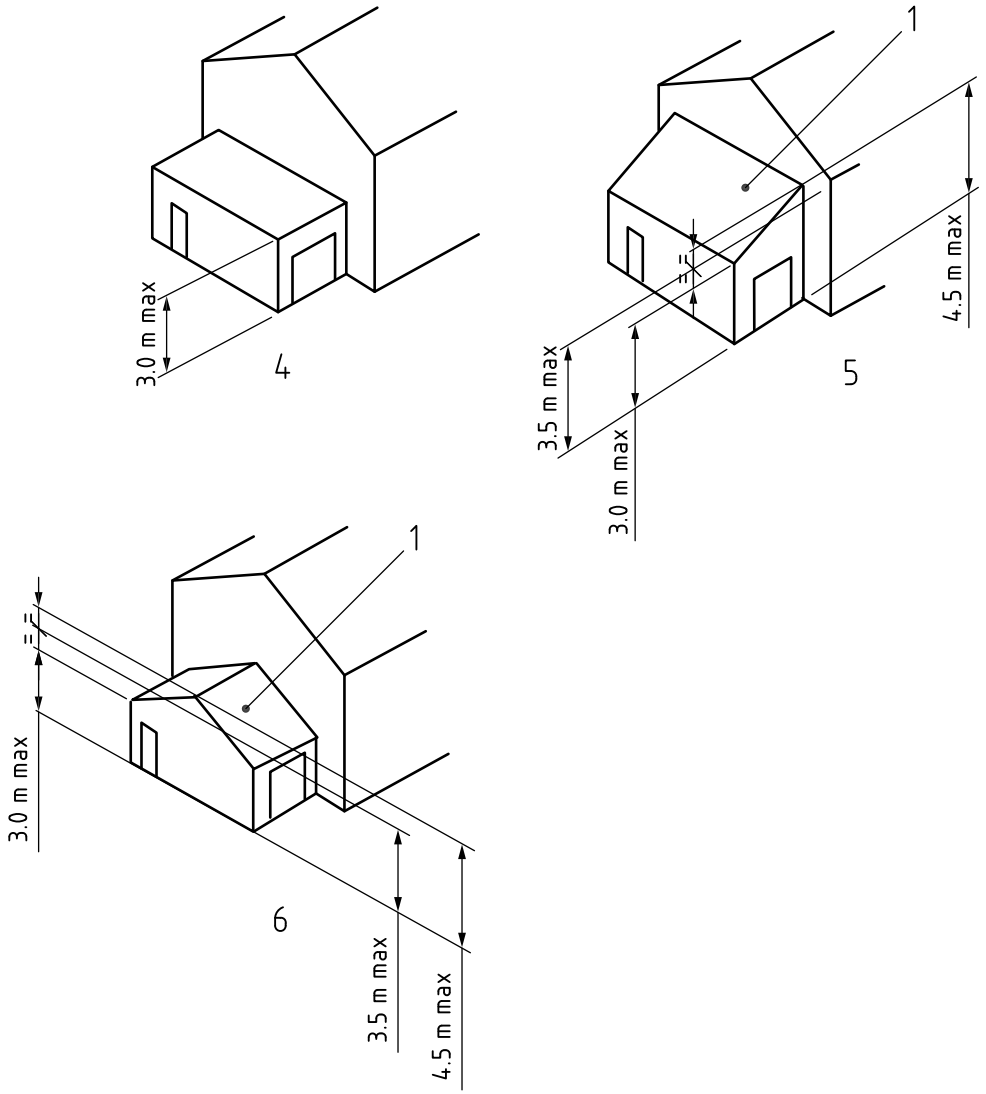
Wall heights should be measured from the top of the foundation or from the underside of the floor slab where this provides effective lateral restraint.

Figure A.1 **Size and shape of buildings or annexes [see also A.1g) and A.4]**



a) Buildings

Figure A.1 **Size and shape of buildings or annexes [see also A.1g) and A.4]**

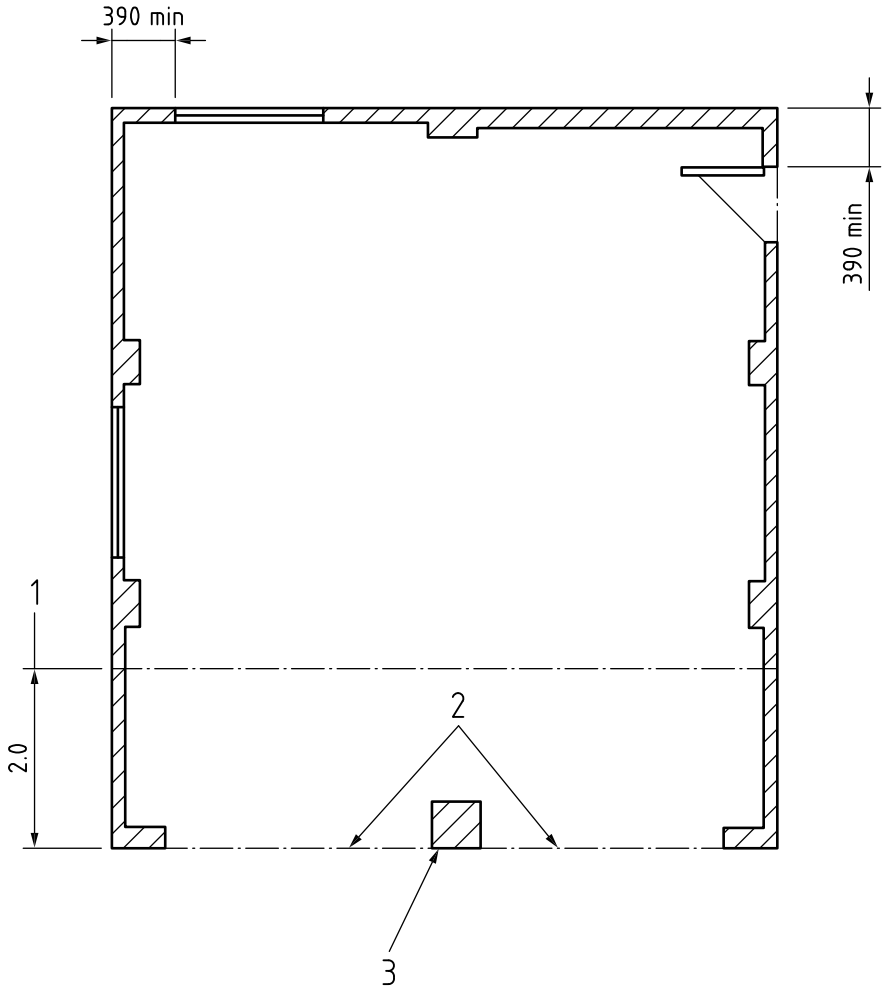


b) Annexes

Key

1	Roof, maximum slope 40°	4	Flat roof annexe
2	Flat roof building	5	Pitched roof annexe (type 1)
3	Pitched roof building	6	Pitched roof annexe (type 2)

Figure A.2 **Location of openings**

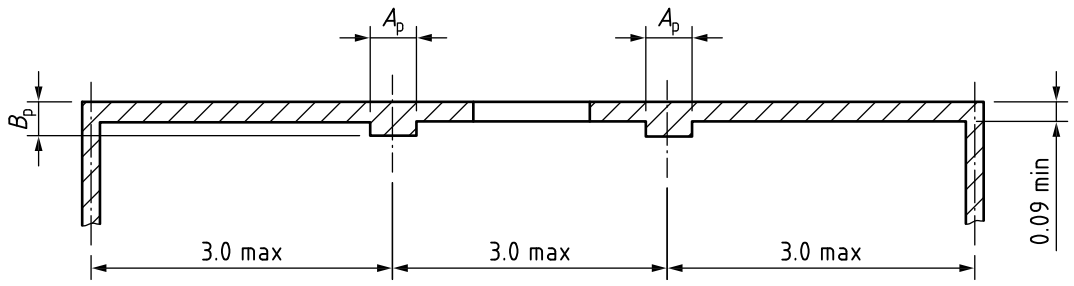


Key

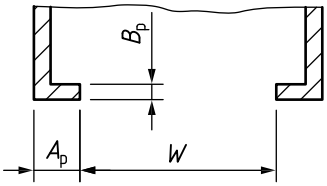
1 No other openings in this zone
2 Wall with major openings
3 Isolated column (see Figure A.4)

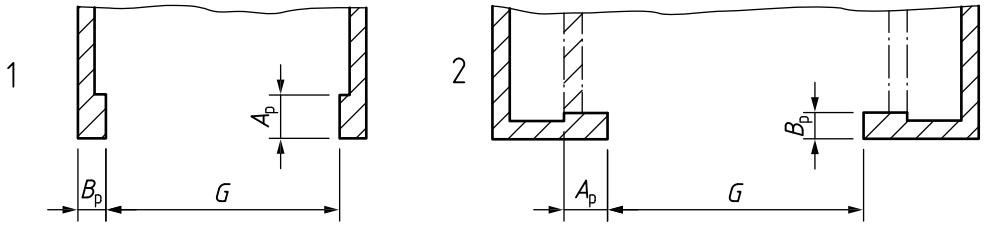
Figure A.3 **Wall thicknesses**

Dimensions in metres

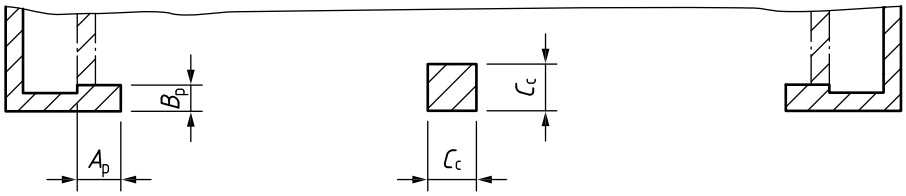


a) Wall without a major opening





b) Wall with a single major opening



c) Wall with two major openings

The minimum pier size ($A_p \times B_p$) should be 390 mm × 190 mm or 327 mm × 215 mm depending on size of masonry units.

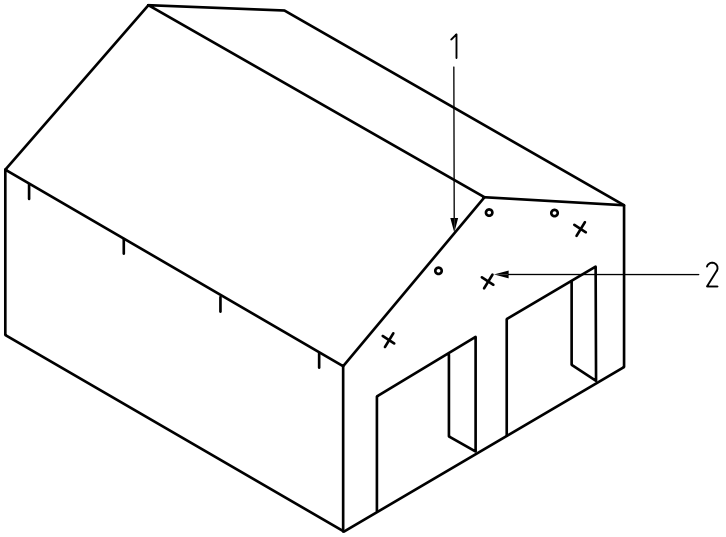
Isolated column, c), to be 325 mm × 325 mm minimum ($C_c \times C_c$).

Key

1 Orientation of piers with opening width *G* not greater than 2.5 m

2 Orientation of piers with opening width *G* greater than 2.5 m

Figure A.4 **Horizontal lateral restraint at roof level**



Key
1 Fixing near ridge position
2 Fixing at isolated column position
l Denotes fixings at eaves level
× Denotes fixings at base of gable
° Denotes fixings along roof slope

Annex B (normative) Design provisions for movement in masonry

B.1 General

Joints in masonry walls to accommodate movement are not normally required for low-rise buildings. However, where walls have long unbroken runs, the inclusion of movement joints should be as recommended in **B.2**. Where such joints are incorporated in a design in accordance with this British Standard the designer should decide whether, in view of the breaks of continuity introduced, a more detailed structural design is required to ensure its structural stability is not affected.

NOTE 1 Dimensional changes in masonry walls arise due to both moisture and temperature changes. Clay brickwork tends to expand and calcium silicate brickwork, concrete brickwork and blockwork tends to shrink.

NOTE 2 Movement joints are not normally required to continue below ground level DPC except at changes of level.

*NOTE 3 Detailed guidance on the design of movement joints can be found in PD 6697:2010, **6.2.6**.*

B.2 Spacing of movement joints

For clay brickwork, movement joints should be used at between 12 m and 15 m centres.

For calcium silicate brickwork, movement joints should be used at between 7.5 m and 9 m centres. For concrete brickwork and blockwork, movement joints should be used at between 6 m and 9 m centres.

For natural stone masonry, movement joints should be used at between 15 m and 20 m centres.

B.3 Design features requiring movement joints

B.3.1 Change of height

Movement joints should be provided where there is a change in height in the external walling (see Figure B.1).

B.3.2 Offsets

Movement joints should be provided where an offset is produced (on plan) that is less than 675 mm (see Figure B.2).

B.3.3 Terraced housing

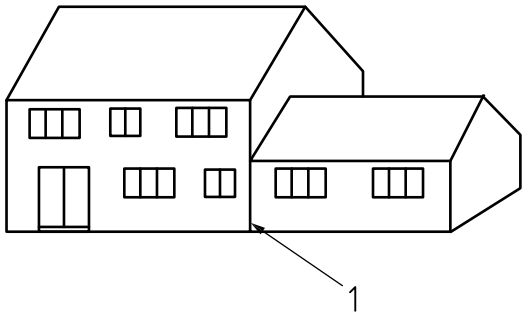
Movement joints should be provided in the external walling of terraced housing at the spacing given in **B.2** (see Figure B.3).

B.4 Bed joint reinforcement

Bed joint reinforcement conforming to BS EN 845-3 can be used in masonry walls to minimize cracking; this can occur above or below openings where the vertical cross-sectional area of the masonry is much less than that of the masonry on either side. The reinforcement should be long enough to distribute the stress to a position where the vertical cross-sectional area of the wall is able to accommodate it. Reinforcement should be protected against corrosion in accordance with PD 6697:2010, Table 2 or NA to BS EN 1996-1-1:2005, Table NA.8. External leaves should have stainless steel reinforcement.

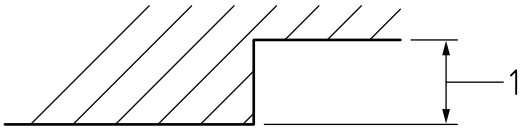
NOTE For further details see PD 6697:2010, ***6.2.6****.*

Figure B.1 **Movement joint at change in external wall height**



Key
1 Movement joint required

Figure B.2 **Offsets**



Key
1 If less than 675 mm a movement joint is required

Figure B.3 **Movement joints in terraced housing**

Key
1 Movement joints

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 1991-1-4: *Eurocode 1: Actions on structures – Part 1-4: General actions – Wind actions*

Further reading

BS 6649, *Specification for clay and calcium silicate modular bricks*

BS EN 1991-1-7, *Eurocode 1: Actions on structures – Part 1-7: General actions – Accidental actions*

BS EN 1996-1-2, *Eurocode 6: Design of masonry structures – Part 1-2: General rules – Structural fire design*

NA to BS EN 1991-1-7:2006, *National Annex to Eurocode 1: Actions on structures – Part 1-7: Accidental actions*

NA to BS EN 1996-2, *UK National Annex to Eurocode 6: Design of masonry structures – Part 2: Design considerations, selection of materials and execution of masonry*

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