The Small Buildings Structural Guidance

Building Standards Division
Directorate for the Built Environment

July 2010

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July 2010

version 1.0

Document Version Control

Title: The Small Buildings Structural Guidance

Purpose: The Small Buildings Structural Guidance provides structural guidance to designers of small domestic buildings on how to comply with standard 1.1.

Version	Date	Notes
1.0	08/07/10	The guidance given in this document replicates the Small Buildings Structural Guidance published in Section 1 (annexes 1.A to 1.F) of the Technical Handbooks up until 30 September 2010.

Introduction

The Small Buildings Structural Guidance (SBSG) provides structural guidance to designers of small domestic buildings on how to comply with standard 1.1. This document replicates the guidance that was published in Section 1 (annexes 1.A to 1.F) of the Technical Handbooks up until 30 September 2010.

The SBSG is mainly based on British Standards which have now been withdrawn. In light of this the Building Standards Division of the Scottish Government (BSD) removed the SBSG from the Technical Handbook on the 1 October 2010 and is currently considering whether to update it in line with the Structural Eurocodes. Therefore care should be taken when using this guidance.

The British Standards Institution (BSI) agreement with the European Committee for Standardisation (CEN) obliges it to withdraw UK national standards after a harmonised European Standard with the same scope and field of application has been produced (31 March 2010). Withdrawal of a standard implies that while documents will still be available there will be no support or five-year review by a BSI committee to consider the currency of the standard and to decide whether it should be confirmed, revised or withdrawn. BSI, in line with this commitment replaced the British Standards relating to loading and structural design with the European Standards and associated National Annexes. Whilst other guidance documents or international standards, including withdrawn national standards and the SBSG might be used in alternative approaches to satisfy building regulations, designers, verifiers, or in the case of certified projects, the approved certifiers of design (building structures) will need to satisfy themselves that the use of such guidance is appropriate for a specific project.

BSD has already commissioned research on the impact of the change to Structural Eurocodes on the guidance given in Annex 1.D Masonry Walls of the SBSG http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/publications/pubresearch/researchstruc).
This concluded that there should be a reduction in the allowable building height for masonry buildings, designed to the SBSG, in some areas of Scotland if this guidance is to be updated.

Section 1 of the 2010 Domestic Technical Handbook does reference BS 8103-3: 2009 “Structural design of low-rise buildings - Code of practice for timber floors and roofs for housing”. This British Standard has recently been revised and is compatible with the Structural Eurocodes.

Contents

Annex

1.A General

contents

1.A.0 Introduction

The Small Buildings Structural Guidance (SBSG) replaces the Small Buildings Guide (second edition 1994) and provides structural guidance to designers of small domestic buildings and is subdivided into 6 annexes:

Annex 1.A - General
Annex 1.B - Stability
Annex 1.C - Foundations
Annex 1.D - Masonry walls
Annex 1.E - Timber frame walls
Annex 1.F - Timber floors and roofs

The *buildings* covered by this guidance are restricted in terms of construction type, size and subsoil conditions to those commonly occurring in Scotland. Following the guidance in the annexes will help designers meet standard 1.1.

This guidance has been written for those with expertise in *building* design and construction but not necessarily in structural engineering design. Where the conditions or parameters fall outside the scope then specialist advice should be sought from chartered engineers or other appropriately qualified persons.

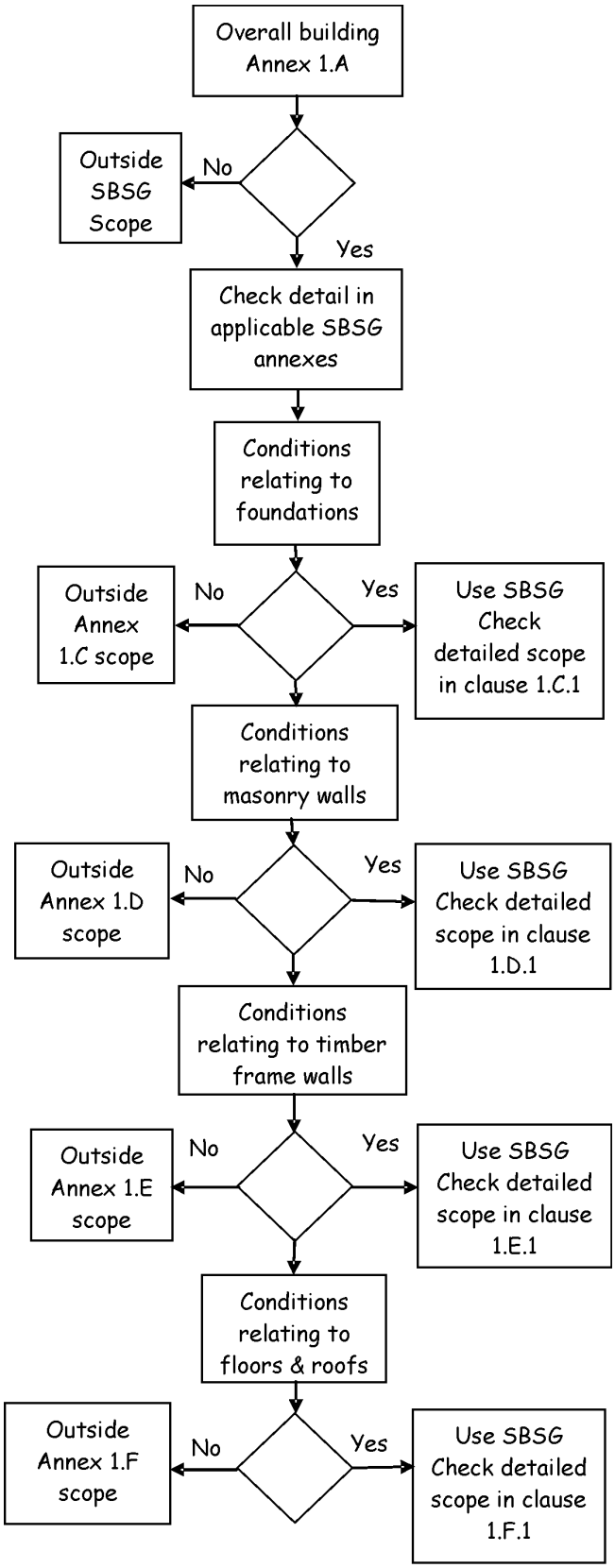
Timber frame construction has been a significant form of construction for *domestic buildings* for over 20 years in Scotland, rising from 38% of new starts in 1984 in the volume housing market to over 73% in 2004, and a large proportion of the single build and extension market. Although the guidance in the Small Buildings Guide was restricted to traditional masonry construction as timber frame construction has been used and accepted for over 30 years, it was considered necessary to extend the scope of the guidance for small buildings to include timber frame walls.

1.A.1 Scope

This guidance covers the following types of buildings:

a. buildings with masonry walls:
   - *domestic buildings* but restricted to houses not more than 3 storeys without basement storeys;
   - extensions with eaves heights not more than 3 m to low rise *domestic* buildings including garages and outbuildings;
   - single *storey* , single leaf buildings forming a garage or outbuilding within the *curtilage* of a *dwelling.*
b. buildings with timber frame walls:
   - *domestic buildings* but restricted to houses not more than 2 storeys without basement storeys;
   - extensions with eaves heights not more than 3 m to low rise domestic buildings.

The full description of the types of *buildings* and restrictions to which this guidance is applicable is set out within the scope of each of the annexes and it is recommended that prior to using the SBSG for particular works, the scope of the works should be checked against all of the limitations on its use to ensure that it is appropriate in the circumstances and in particular the items set out as follows:



Annex 1.A General
Experienced in design & construction
Domestic buildings & extensions.

Annex 1.C Foundations
Geotechnical conditions.

Annex 1.D Masonry walls
Not more than 3 storeys;
Maximum 15 m *building* height;
Maximum 12 m length between supporting walls;
Limitations of wind speed, topography, altitude and location;
Limitations of floor areas surrounded by structural walls to 70 and 36 m^2;
Openings in walls not more than 3 m in length.

Annex 1.E Timber frame walls
Not more than 2 storeys;
Maximum 10 m *building* height;
Maximum 9 m length between supporting walls;
Limitations of wind speed, topography, altitude and location;
Limitations of floor areas surrounded by structural walls to 70 and 36 m^2;
Openings in walls totalling not more than 30% of the wall area.

Annex 1.F Floors and roofs
Floor spans not more than 5.4 m;
Roof spans not more than 6 m;
Roofs should be either square or rectangular plan shape;
Raised tie and collared roofs only for attic storage loading;
Trussed rafters restricted to prefabricated duo or mono pitch fink trussed rafters;
Roof members imposing point loads onto walls (e.g. hip and girder trusses) out with scope;
Engineered timber I joists, concrete floors out with scope.

Design and construction should also comply with all other relevant building standards.

Annex 1.B provides guidance on stability which should be followed.

Annexes 1.C-1.F can be used independently of each other.

Where there is a minor departure from the recommendations within the SBSG this may be supported by calculations carried out by a specialist provided the design of that specialist is properly co-ordinated with the remainder of the design.

1.A.2 Latest changes

The Small Buildings Guide has been revised and updated to the Small Buildings Structural Guidance incorporating changes in construction practice specifically:

Loadings

- wind loading and snow loading.

Masonry walls

- more detailed guidance on openings;
- more detailed guidance on lateral support;
- differences in ground levels either sides of walls;
- stainless steel wall ties in all locations.

Timber Floors and Roofs

- guidance clarified and expanded for floor joists;
- timber span tables expanded to cover raised tie and collared roofs.

Timber frame construction

- new guidance on masonry clad timber frame walls.

1.A.3 Explanation of terms

The following terms are used in the SBSG in addition to the definitions and explanation of terms in Appendix A of the Technical Handbooks.

Buttressing wall means a wall designed and *construct*ed to afford lateral support to another wall perpendicular to it, support being provided from the base to the top of the wall.

Cavity width means the horizontal distance between the 2 leaves of a cavity wall.

Pier means a member which forms an integral part of a wall, in the form of a thickened section at intervals along the wall so as to afford lateral support to the wall to which it is bonded or securely tied.

Centres means the distance between the longitudinal centres of any 2 adjacent members of the same type, measured in the plane of floor, ceiling or roof structure of which the members form a part.

Span means distance measured along the centre line of a member between the centres of any 2 adjacent bearings or supports. Note: The spans given in annex 1.E for Cripple Studs and Lintels and in annex 1.F for floor joists and roof joists are the clear spans (i.e. spans between the faces of the supports).

Supported wall means a wall to which lateral support is afforded by a combination of buttressing walls, piers or chimneys acting in conjunction with floors or roof.

Lateral support means support provided to a wall by another wall, pier etc. perpendicular to it which will restrict movement in the direction of the thickness of a wall from the base to the top of the wall.

Horizontal diaphragm means a floor or roof construction which acts to transfer the wind loads to the supporting walls.

Load bearing wall means a wall which carries vertical and/or lateral loads in addition to its self weight.

Annex
1.B Stability

contents

1.B.0 Introduction

Buildings should be stable under the likely combinations of *dead load , imposed load* and *wind loading* terms of the individual structural elements, their interaction together and overall stability as a structure. This annex provides guidance on the principles of stability and provisions which should be taken with respect to all forms of *buildings* within the scope of the SBSG.

1.B.1 Stability recommendations

The following provisions should be made to ensure the stability of the *building*:

a. the overall size and proportioning of the *building* should be limited in accordance with the specific guidance for each form of *construction*;
b. a layout of internal walls and *external walls* forming a robust three dimensional box structure in plan should be *constructed* with restrictions on the maximum size of cells measured in accordance with the specific guidance for each form of *construction*;
c. the internal walls and *external walls* should be connected by either masonry bonding or by using mechanical connections;
d. the intermediate floors and roof should be of such *construction* and interconnection with the walls that they provide local support to the walls and also act as horizontal diaphragms capable of transferring the *wind loads* to buttressing elements of the *building*.

More detailed guidance is provided in annexes 1.C-1.F.

1.B.2 Timber roof bracing

Trussed rafter roofs should be braced in accordance with the recommendations of BS 5268-3: 2006. A traditional cut timber roof (i.e. using rafters, purlins and ceiling joists) generally has sufficient built-in resistance to instability and *wind loads* (e.g. from either hipped ends, tiling battens, rigid sarking etc.). However, diagonal rafter bracing, equivalent to that recommended in BS 5268-3: 2006 or annex H of BS 8103-3: 1996 for trussed rafter roofs, should be provided particularly for single-hipped and non-hipped roofs of more than 40 degree pitch to detached *houses*.

Annex
1.C Foundations

contents

1.C.0 Introduction

The *dead loads, imposed loads* and *wind loads* are transmitted from the *building* to the subsoil by means of the *foundations* which should be designed taking into account the loadings and the subsoil conditions without undue settlement.

This annex provides guidance on the subsoil conditions on which *buildings* within the scope of the SBSG can be *constructed*, the precautions to be taken and guidance on strip *foundations* of plain concrete for such *buildings*.

Where the subsoil or *foundation* conditions or parameters fall outside the scope then specialist advice should be sought from chartered engineers or other appropriately qualified persons.

1.C.1 Explanation of terms

The following terms are used in annex 1.C in addition to the definitions and explanation of terms in Appendix A of the Technical Handbooks

Engineered fill means fill that is selected, placed and compacted to a specification that it will exhibit engineering behaviour. Normally the installation of such fill would not have taken place prior to development of the *site* allowing the necessary control to be exercised over the type of fill material and method of placement.

Non-engineered fill means fill that has arisen as a by-product of human activity, usually involving the disposal of waste materials. Normally such fill would occur on *sites* where uncontrolled filling has taken place and therefore no reliance can be placed on the type of fill material and method of placement and hence its ability to support *buildings* .

Bearing stratum means the formation level of the ground on to which the *foundation* of a *building* will be *constructed*.

1.C.2 Subsoil conditions

This guidance is limited to there being no:

- non-engineered fill or wide variation in type of subsoil within the loaded area; or
- peat within the loaded area; or
- weaker type of soil within the loaded area at such a depth below the soil on which the *foundation* rests or other conditions which could impair the stability of the *building*.
- subsoil below the *foundation* , or in the case of an extension below either the existing *building* or the extension outwith Types I-VI in the table to clause 1.C.6;
- subsoil below the *foundation* , or in the case of an extension below either the existing *building* or the extension, that has been subjected to ground improvement techniques (e.g. vibrocompaction, underpinning, soil replacement etc.);
- doubt about the ability of the ground to sustain loads transmitted to it;

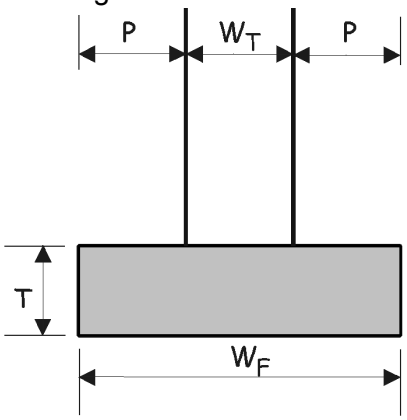
The minimum depth to the bearing stratum for the *foundations* should be determined by the greatest of:

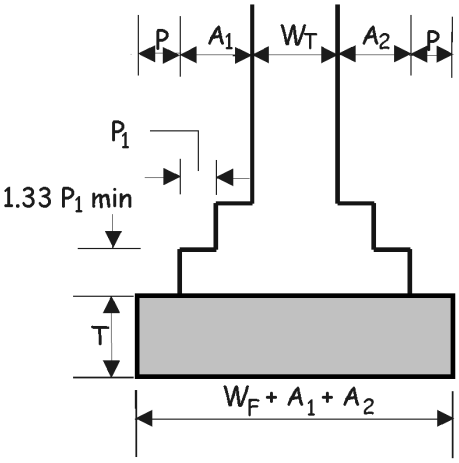
- the depth to selected bearing stratum; or
- a depth of 450 mm to the underside of *foundations*. This should avoid damage from frost although this depth may have to be increased in areas which are subject to long periods of frost; or
- a depth of 600 mm to the underside of *foundations* where clay soils are present (more detailed guidance is provided in BRE Digests 240 and 241) ; or
- the depth required in order to reach ground types I –VI in the table to clause 1.C.6.

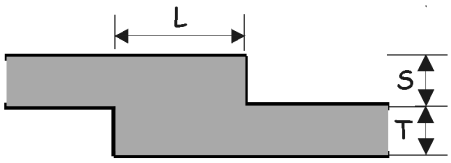
1.C.3 Design

The design of *foundations* should comply with all of the following:

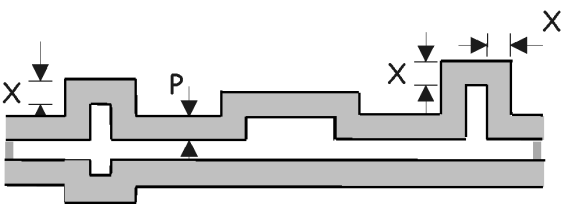
a. the *foundations* are situated centrally under the wall (except as in clause 1.C.4);
b. the *foundations* are strip *foundations*;
c. the *foundation* width should not be less than the dimension, W_F, in the table to 1.C.6 and at least as wide as the supported wall;
d. concrete in chemically non-aggressive soils is composed of Portland cement to BS EN 197-1 & 2: 2000 and fine and coarse aggregate conforms to BS EN 12620: 2002 and the mix complies with one of the following recommendations:
   - in proportion of 50 kg of Portland cement to not more than 100 kg (0.05 m^3) of fine aggregate and 200 kg (0.1 m^3) of coarse aggregate; or
   - grade ST2 or grade GEN1 concrete to BS 8500-2: 2002;
e. in chemically aggressive soils, follow the guidance provided in BS 8500-1: 2002 and BRE Special Digest 1;
f. the minimum thickness, T, of the concrete *foundation* is 150 mm or the scarcement width, P, whichever is the greater, where P is derived using the table to clause 1.C.6 and the diagram opposite. Trench fill *foundations* may be used as an alternative to strip *foundations;*
g. where footings have regular offsets these offsets should have a depth of at least 1.33 times the projection, P_1, with the overall width not less than the sum of W_F (from the table to clause 1.C.6) plus the offset dimensions A_1 and A_2 and the walls should be central on the *foundation*;
h. for *foundations* stepped in elevation:
   - height of steps, S, should be no more than the *foundation* thickness, T; and
   - overlap, L, should be twice the step height, S, the *foundation* thickness, T, or 300 mm whichever is the greatest;
i. *foundations* for piers, buttresses and *chimneys* should project as shown in the diagram opposite, where X must be not less than P.







L = greater of 2 x S, T, or 300 mm



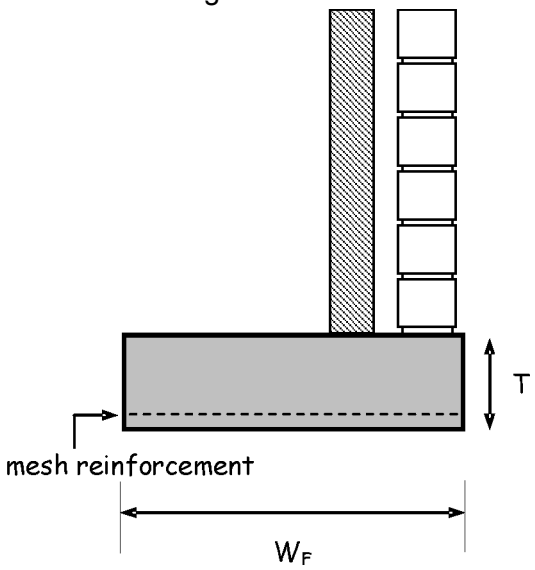
1.C.4 Eccentric *foundations*

This guidance is limited to:

- single *storey buildings* of 4.5 m maximum height where a wall is to be *construct* ed either against a *boundary* or against an existing wall where it is not possible to *construct* the wall centrally on the *foundation* ;
- masonry cavity or timber frame walls with masonry outer leaf with either a flat or pitched roof;
- similar ground conditions to types I-VI from the table to clause 1.C.6 below both the existing and new *foundations* ;
- the *foundations* complying with all of the clauses of this annex.

The design of eccentric foundations should comply with all of the following:

- the minimum *foundation* width, W_F, should be read from the table to 1.C.6;
- the minimum *foundation* thickness, T, for the minimum *foundation* widths listed in the table to 1.C.6 should be at least 200 mm;
- steel mesh reinforcement (e.g. A142) should be placed with 50 mm cover from the base of the *foundation;*
- where the wall and its *foundation* is to be *constructed* against an existing wall then the *foundation* should also follow the guidance in clause 1.C.5.

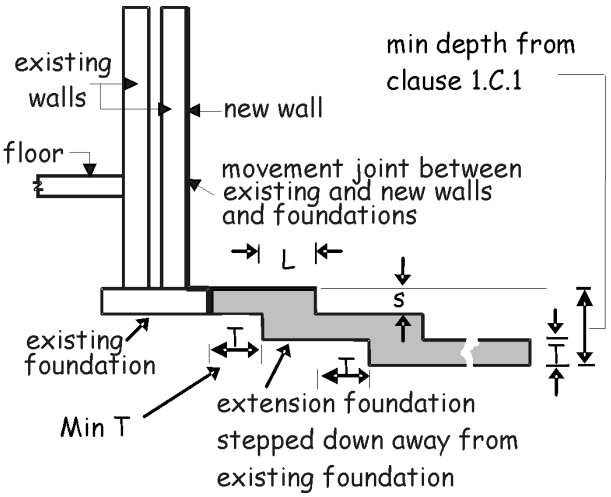


1.C.5 Extensions to existing *buildings*

This guidance is limited to:

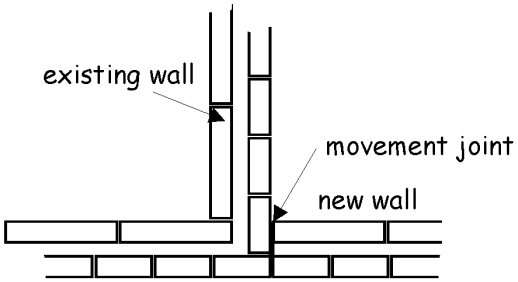
- extensions of not more than 2 *storeys* connected to existing *buildings;*
- masonry cavity or timber frame walls with masonry outer leaf with either a flat or pitched roof;
- similar ground conditions to types I-VI from the table to clause 1.C.6 below both the existing and new *foundations* ;
- extension *foundations* complying with all of the clauses of this annex.

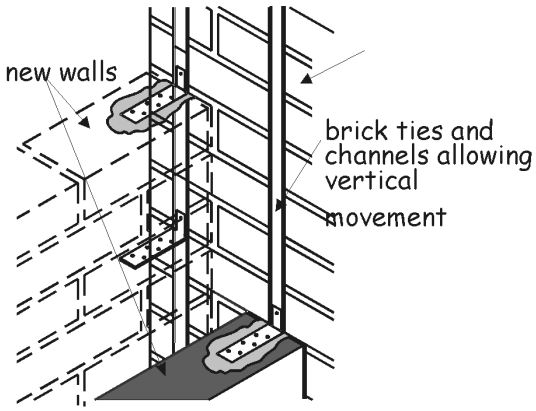
Where the depth of the existing *foundation* is less than that in clause 1.C.2, the depth of the extension *foundation* should match the depth of the existing foundation at the interface and step down progressively to that in clause 1.C.2 as shown opposite. The initial step down in the underside of the new *foundation* should not commence until the horizontal distance from the vertical face of the existing *foundation* is at least the *foundation* thickness, T.



To minimise the risk of differential settlement occurring between the extension and the existing structure, the following should be considered:

- movement joints should be placed between the existing and new *foundations* and walls to accommodate any differential settlement *;*
- for soil types I-III in the table to clause 1.C.6, the strip *foundation* widths listed in the table should be adopted;
- for soil types IV, V and VI in the table to clause 1.C.6, the strip *foundation* widths listed in the table should be increased by 25%;
- additional information is provided in BRE GBG 53 'Foundations for low-rise building extensions';
- where a new roof connects to an existing roof, the loads from the new roof should be carried down to the new *foundation* and no new loads should be carried by the existing structure.





1.C.6 Minimum width of strip *foundations*

The recommended widths of *foundations* set out in the table below may be used subject to:

- the subsoil conditions in clause 1.C.2; and
- the *foundation* design provisions in clause 1.C.3; and
- the type and condition of subsoil at the selected bearing stratum being Types I-VI below; and
- the loading at the base of the wall being within the limits set out below; and

An excavation may be required to establish the type and condition of the ground.

The table below is applicable only within the strict terms of the criteria described within it. Where the ground type is not covered by the table or where x appears specialist advice should be sought from chartered engineers or other appropriately qualified persons.

Minimum width of strip *foundations*

Type of ground (including engineered fill)	**Condition of ground**	**Field test applicable**	**Total load of load-bearing walling not more than (kN/m)**					
			20	**30**	**40**	**50**	**60**	**70**
			Minimum width of strip foundation, W_F (mm)					
I Rock	Not inferior to sandstone, limestone or firm chalk	Requires at least a pneumatic or other mechanically operated pick for excavation	At least equal to the width of the wall					
II Gravel or Sand	Medium dense	Requires pick for excavation. Wooden peg 50 x 50 mm in cross section, hard to drive beyond 150 mm	250	300	400	500	600	650
III Clay or Sandy clay	Stiff	Can be indented slightly by thumb	250	300	400	500	600	650
IV Clay or Sandy clay	Firm	Thumb makes impression easily	300	350	450	600	750	850
V Sand, Silty Sand or Clayey Sand	Loose	Can be excavated with a spade. Wooden peg 50 x 50 mm in cross section can be easily driven	400	600	x	x	x	x
VI Silt, Clay, Sandy clay or Silty clay	Soft	Finger pushed in up to 10 mm	450	650	x	x	x	x
VII Silt, Clay, Sandy clay or Silty clay	Very soft	Finger easily pushed in up to 25 mm	x	x	x	x	x	x

1.C.7 Foundation loads

The table below gives indications of typical loads on *foundations*.

Storeys No.	Wall type	Roof span (m)	Floor span (m)	Loading (kN/m)
3	Masonry cavity	12	6	80
3	Masonry cavity	7.5	6	70
2	Masonry cavity	12	6	60
2	Masonry cavity	7.5	6	50
2	Timber frame	7.5	6	40
1	Masonry cavity	7.5	6	30
1	Timber frame	7.5	6	30
1	Single leaf masonry	5	5	20

Annex
1.D Masonry Walls

continued

contents

1.D.0 Introduction

Small traditional masonry wall *buildings* can be designed to take into account loading conditions, limitations on dimensions, openings, subject to restraint conditions.

This annex provides guidance for traditional masonry wall *construction* for the following *building* types:

a. *domestic buildings* of not more than 3 *storeys* where loading criteria for individual floors does not exceed those given in clause 1.D.4 and total limit of loading does not exceed that given in clause 1.D.26;
b. single *storey,* single leaf extensions to *domestic buildings* including garages and outbuildings that do not exceed the dimensional criteria set out in clause 1.D.2b;
c. single *storey*, single leaf *buildings* forming a garage or outbuilding within the *curtilage* of a *dwelling* that do not exceed the dimensional criteria set out in clause 1.D.2c.

1.D.1 Wall types

This annex provides guidance only for the types of wall extending to full *storey* height set out below:

a. *domestic buildings* of up to 3 *storeys*:
   - *external walls*
   - internal load bearing walls
   - *separating walls*
b. single *storey,* single leaf *domestic buildings* and extensions
   - *external walls*
   - internal load bearing walls

It also provides guidance on parapet walls.

This annex should be used in conjunction with annex 1.B and:

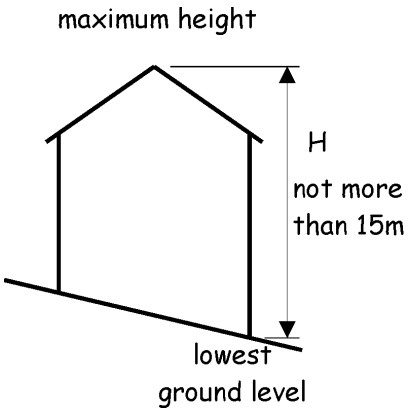
a. if wall thickness is to be determined according to clauses 1.D.5-13 all the design conditions given in this annex should be satisfied;
b. walls should be designed in accordance with the guidance in BS 5628-3: 2005, except as regards the conditions given in clauses 1.D.2- 4,1.D.14-42;
c. in formulating the guidance of this annex, the worst combination of circumstances likely to arise was taken into account;
d. if a requirement of this annex is considered too onerous in a particular case then adequacy by calculation should be shown in respect of the aspect of the wall which is subject to the departure rather than for the entire wall;
e. where the conditions or parameters fall outside the scope of this annex then specialist advice should be sought from chartered engineers or other appropriately qualified persons;
f. the guidance given in this annex is based upon unit compressive strengths of bricks and blocks being at least that indicated in the tables to clauses 1.D.20-21 and diagrams to clause 1.D.22;
g. BS5628-1: 2005 gives design strengths for walls where the suitability for use of masonry units of other compressive strengths are being considered.

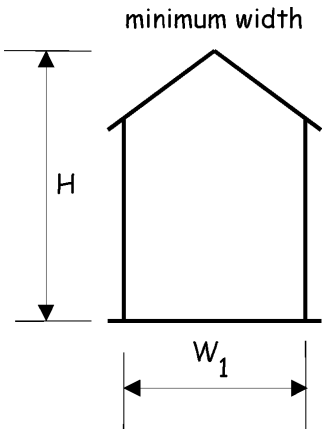
1.D.2 Conditions relating to the building of which the walls forms part

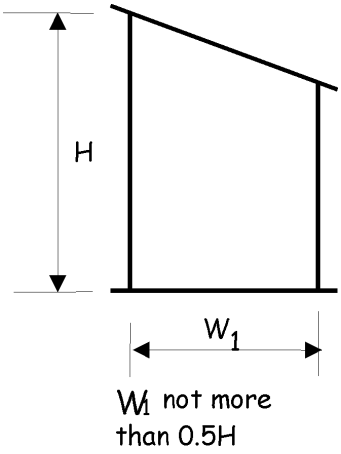
This annex applies only to *buildings* having proportions within the following limits and as shown on the diagrams below subject to the limits of clause 1.D.15:

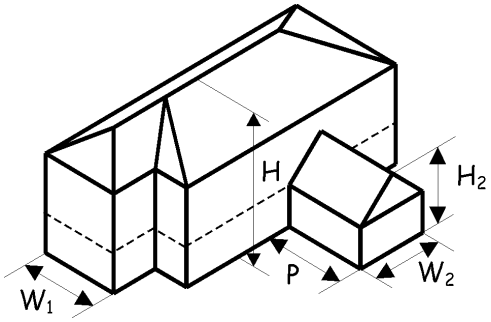
a. domestic buildings of not more than three storeys:

- the maximum height of the *building, H,* measured from the lowest finished ground level adjoining the *building* to the highest point of any wall or roof should be not more than 15 m;
- the height of the *building* H, should be not more than twice the least width of the *building* W_1;
- the height of the wing H_2, should be not more than twice the least width of the wing W_2 when the projection P is more than twice the width W_2.



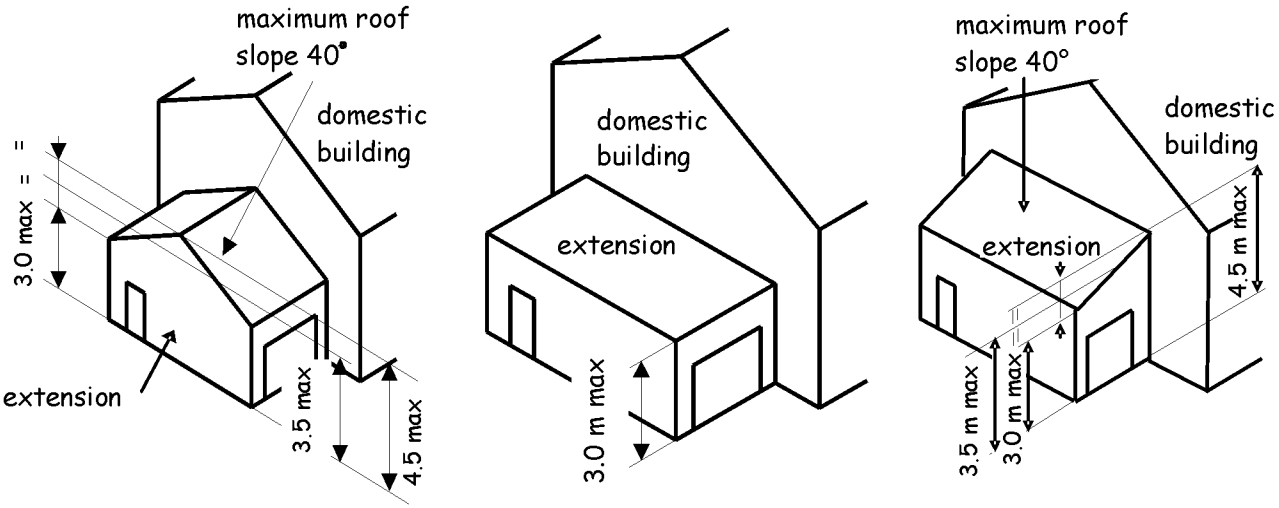






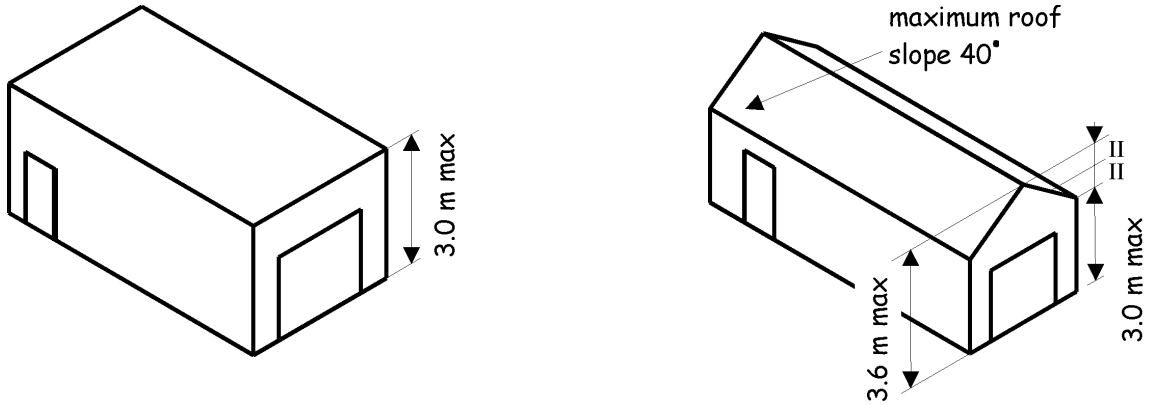
b. size of extensions to domestic buildings

For extensions, height H should be not more than the limits shown below where H is measured from the top of the *foundation* or from the underside of the floor slab where this provides effective lateral restraint.



c. size of single storey, single leaf buildings

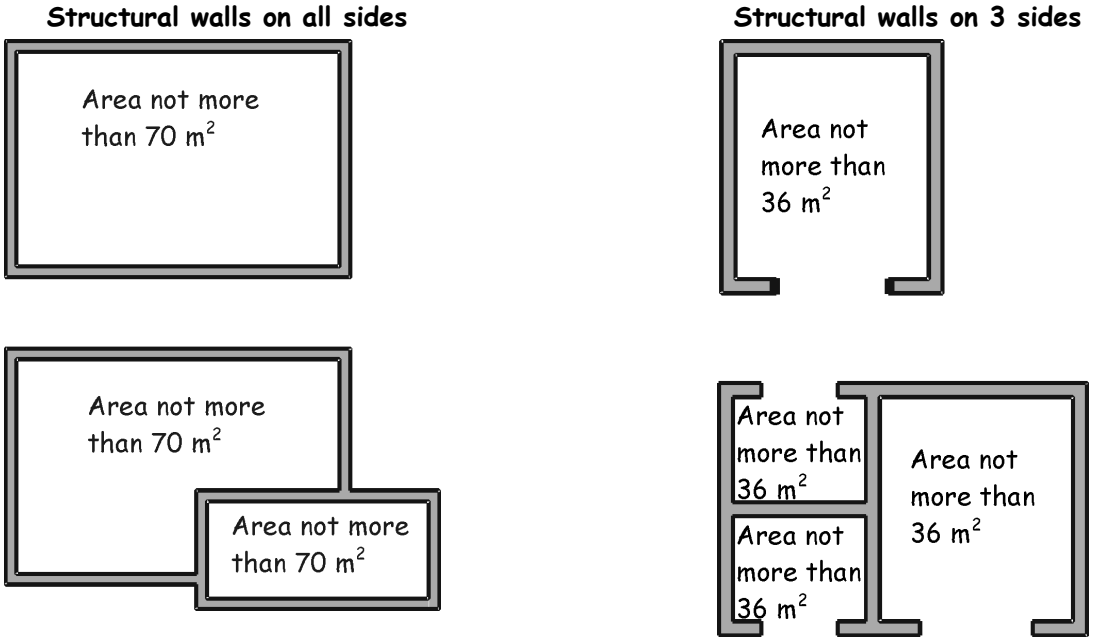
For small single *storey* , single leaf *buildings,* the height H of the *building* should be not more than 3 m and the length should be not more than 9 m where H is measured from the top of the *foundation* or from the underside of the floor slab where this provides effective lateral restraint.



1.D.3 Maximum floor area

The guidance in this annex applies where:

- the areas of floors enclosed by structural walls on all sides are not more than 70 m^2;
- the areas of floors without a structural wall on one side are not more than 36 m^2;
- the openings and recesses are not more than set out in clause 1.D.31;
- the number of areas of floors as above which can be connected should be not more than 4.



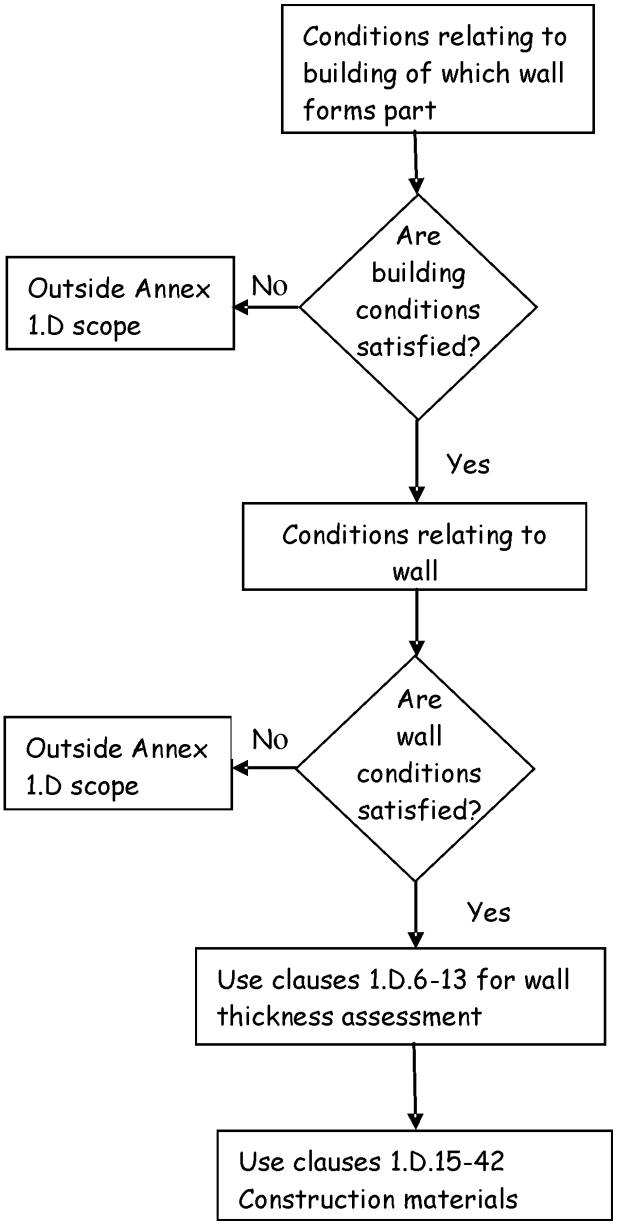
1.D.4 *Imposed loads* on roofs, floors and ceilings

The *imposed loads* on roofs, floors and ceilings should be not more than those in the table below:

Element		Loading
Roof	distributed load:	1.00 kN/m^2 for spans of at least 12 m
	distributed load:	1.50 kN/m^2 for spans of at least 6 m
Floors	distributed load:	2.00 kN/m^2 together with a concentrated load of 1.4 kN
Ceilings	distributed load:	0.25 kN/m^2 together with a concentrated load of 0.9 kN

1.D.5 General

Wall thickness should be determined according to this annex provided the following conditions are met:



Building conditions
limitations on size and proportions of *building* and parts of *building* (clause 1.D.2);
max allowable floor areas (clause 1.D.3);
max *imposed loads* and *wind loads* (clauses 1.D.4 and 1.D.14).

Wall conditions
max allowable length and height of wall (clause 1.D.15);
construction materials (clauses 1.D.17-24);
loading on walls (clauses 1.D.25-26);
end restraints (clauses 1.D.27-29);
openings, recesses, overhangs and chases (clauses 1.D.30-34);
lateral support by floors and roofs (clauses 1.D.35-37);
movement in masonry (clause 1.D.38);
conditions relating to *external walls* of small single *storey buildings* and extensions (clauses 1.D.39-42).

1.D.6 Solid external walls, compartment walls and separating walls in coursed brickwork or blockwork

Solid walls *constructed* of coursed brickwork or blockwork should be at least as thick as 1/16 of the *storey* height and should follow the guidance in the table below.

Height of wall	Length of wall	Minimum thickness of wall
not more than 3.5 m	not more that 12 m	190 mm for the whole of its height
more than 3.5 m but not more than 9 m	not more than 9 m	190 mm for the whole of its height
	more than 9 m but not more than 12 m	290 mm from the base for the height of one *storey* and 190 mm for the rest of its height
more than 9 m but not more than 12 m	not more than 9 m	290 mm from the base for the height of one *storey* and 190 mm for the rest of its height
	more than 9 m but not more than 12 m	290 mm from the base for the height of two *storeys* and 190mm for the rest of its height

1.D.7 Solid *external walls*, *compartment walls* and *separating walls* in uncoursed stone, flints etc.

The thickness of walls *constructed* in uncoursed stone or bricks or other burnt or vitrified material should be at least 1.33 times the thickness recommended in clause 1.D.6.

1.D.8 Cavity walls in coursed brickwork and blockwork

All cavity walls should have leaves at least 90 mm thick and structural cavities at least 50 mm wide. The wall ties should be at horizontal centres of 900 mm and at vertical centres of 450 mm, which is equivalent to 2.5 ties per square metre. Wall ties should be spaced not more than 300 mm apart vertically and within a distance of 225 mm from the vertical edges of all openings, movement joints and roof verges. For selection of wall ties for use in a range of cavity widths refer to the table to clause 1.D.17.

For *external walls*, *compartment walls* and *separating walls* in cavity *construction*, the combined thickness of the 2 leaves plus 10 mm should be at least the thickness required by clause 1.D.6 for a solid wall of the same height and length.

1.D.9 Walls providing vertical support to other walls

Irrespective of the materials used in the *construction*, a wall thickness should be at least that of any part of the wall to which it gives vertical support.

1.D.10 Internal loadbearing walls in brickwork or blockwork

With the exception of *separating walls*, internal loadbearing walls should have a thickness at least:

(wall thickness from clause 1.D.6) / 2 less 5 mm

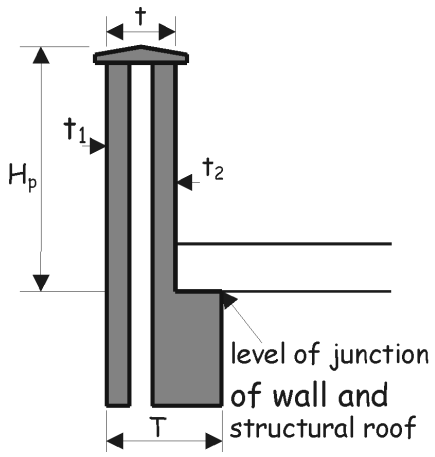
A wall in the lowest *storey* of a 3 *storey building* carrying load from both *upper storeys* however should have a thickness as determined by the above equation or 140 mm, whichever is more.

1.D.11 Parapet walls

The minimum thickness and maximum height of parapet walls should be as given in the tables and diagrams below only where access is limited (e.g. for occasional maintenance).

Cavity wall

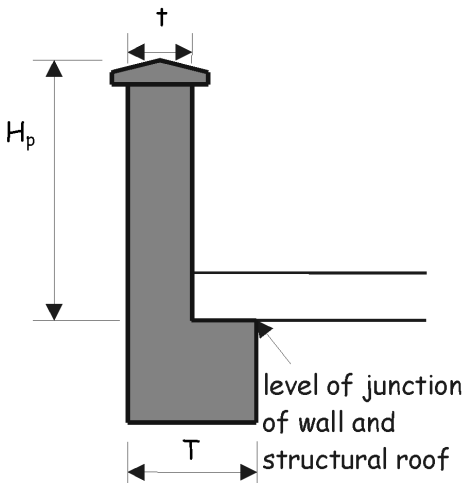
Max parapet height, H_P (mm)	Thickness (mm)
600	$t_1 + t_2$ not more than 200
860	$t_1 + t_2$ more than 200



Solid wall

Max parapet height, H_P (mm)	Thickness (mm)
600	t = 150
760	t = 190
860	t = 215

Note that t must not be more than T



1.D.12 Single leaf external walls

The single leaf of *external walls* to single *storey* single leaf *domestic buildings* and extensions should be at least 90 mm thick, provided the recommendations of clauses 1.D.39-42 are met.

1.D.13 Modular bricks and blocks

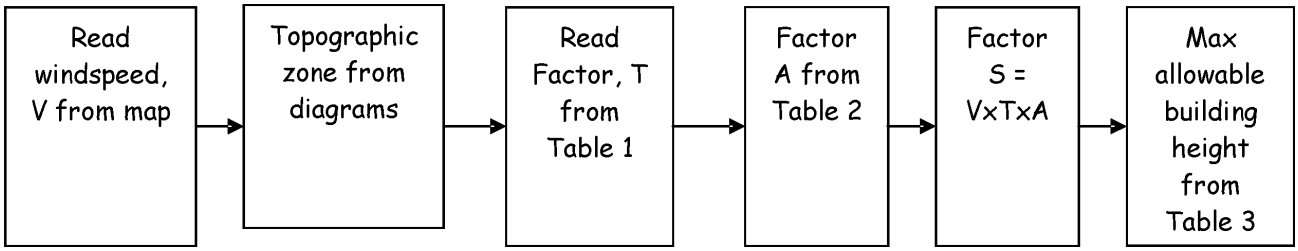
Where brick or block dimensions are based on BS 6649: 1985, wall thicknesses recommended in this annex should not be reduced by more than the tolerance from the work size permitted by a British Standard for equivalent sized bricks or blocks manufactured of the same material.

1.D.14 Maximum height of *buildings* based on *wind loadings*

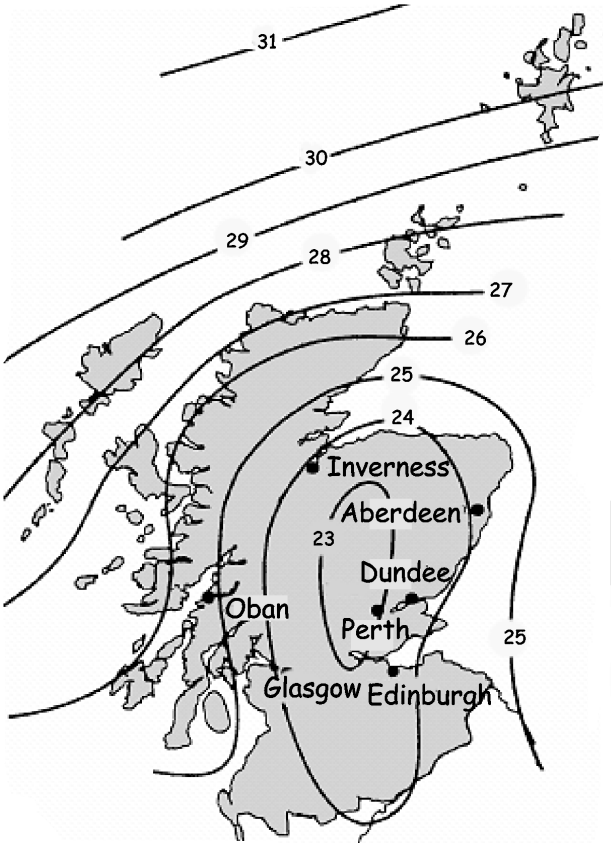
The maximum height of a *building* for the *site* exposure conditions and wind speed should be derived by following the procedure which is set out on the flow chart below using the wind speed map and topographic zone diagrams below and tables 1 and 2 opposite to enable the maximum height of *building* to be read off table 3 opposite.

This design guidance has been revised in accordance with 'Wind loading on traditional dwellings-Amendment of simplified design guidance for the Scottish Office Small Buildings Guide' (1999) (Project number CV4071) and is based on BS 6399-2: 1997 using hourly mean wind speeds. It should be noted that the wind speeds are derived from a different basis than in the former Small Buildings Guide and it is important that they are only applied to the methodology within this annex.

Flow chart for deriving maximum allowable building height

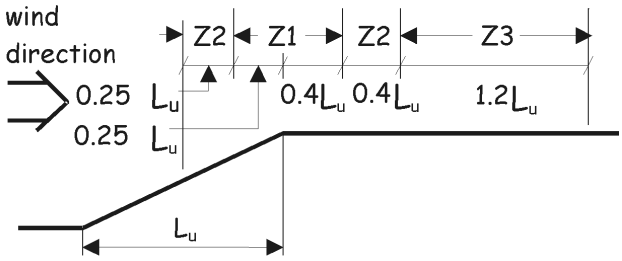


Map of wind speeds (m/sec)



Topographical zones for Table 1

Hills and ridges



Cliffs and escarpments

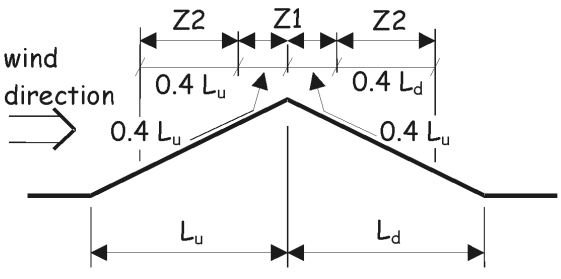


Table 1 - Factor T

Type of terrain	Factor T		
	Zone 1	Zone 2	Zone 3
Category 1: Nominally flat terrain, average slope not more than 1:20	1.00	1.00	1.00
Category 2: Moderately steep terrain, average slope not more than 1:5	1.24	1.13	1.10
Category 3: Steep terrain, average slope more than 1:5	1.36	1.20	1.15

Note that outside of these zones Factor T = 1.0

Table 2 - Factor A

Site altitude (m)	Factor A
0	1.00
50	1.05
100	1.10
150	1.15
200	1.20
300	1.30
not more than 400	1.40

Table 3 - Maximum allowable building height (m)

Factor S	Country Sites Distance to the coast[2]			Town Sites[1] Distance to the coast[2]		
	<10 km	10 to 50 km	>50 km	<10 km	10 to 50 km	>50 km
23	15	15	15	15	15	15
24	15	15	15	15	15	15
25	11	14.5	15	15	15	15
26	8	10.5	13	15	15	15
27	6	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	x	3.5	4	8	9.5	10.5
32	x	3	3.5	7	8.5	9.5
33	x	x	3	6	7.5	8.5
34	x	x	x	5	7	8
35	x	x	x	4	6	7
36	x	x	x	3	5.5	6
37	x	x	x	x	4.5	5.5
38	x	x	x	x	4	5
39	x	x	x	x	3	4
40	x	x	x	x	x	3

Notes:

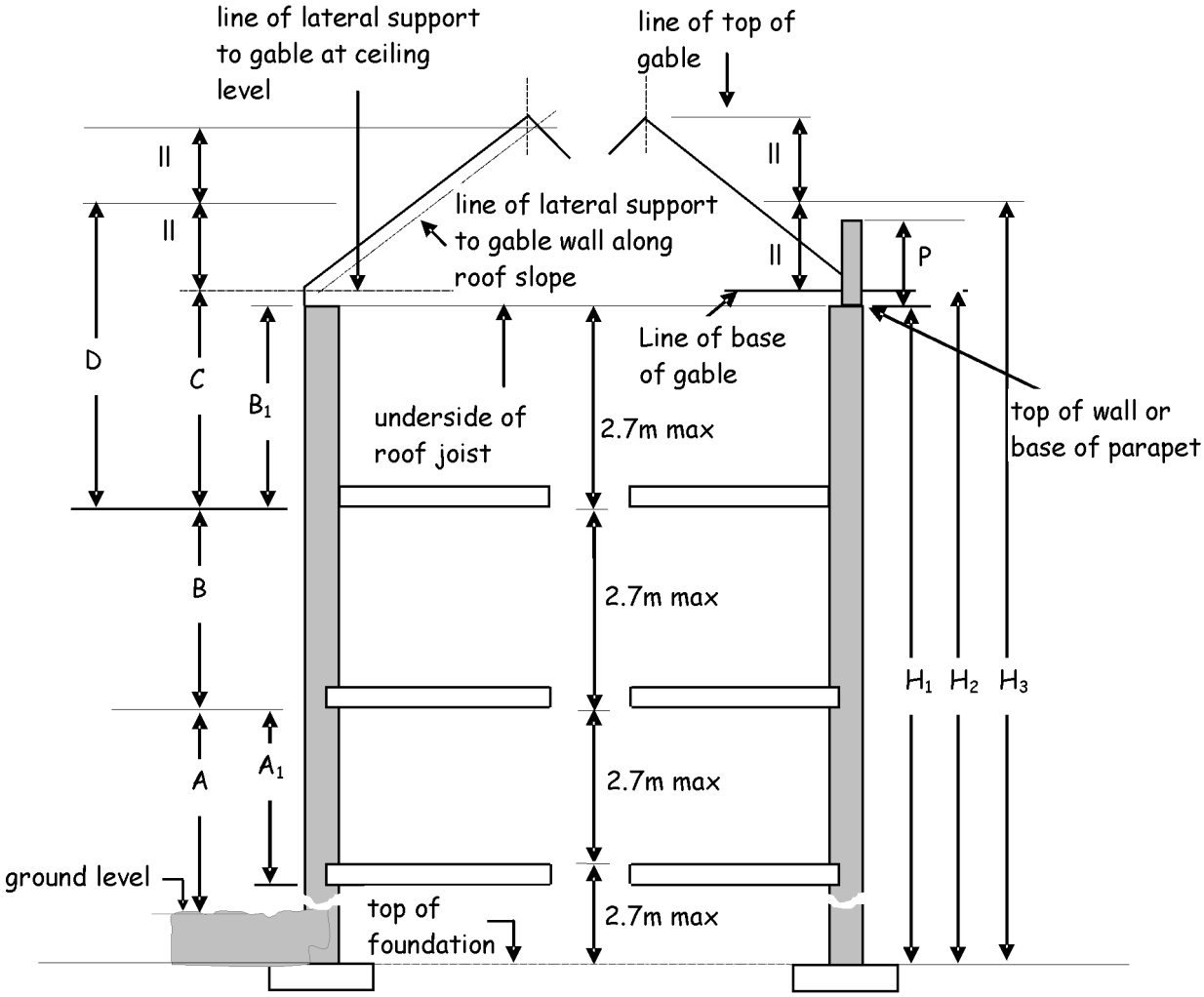
1. For *sites* on outskirts of towns not sheltered by other *buildings* use heights for country *sites*.
2. For *site* nearer than 1 km to inland area of water (e.g. tidal river or loch) which extends more than 1 km in direction of wind, distance to coast should be taken from edge of that inland area of water.
3. x indicates that the *building* height is outwith the scope of the SBSG.
4. The maximum allowable *building* heights may be interpolated within the figures in the table.

1.D.15 Maximum allowable length and height of the wall

This annex does not deal with walls more than 12 m in length, measured from centre to centre of buttressing walls, piers or *chimneys* providing restraint, or of walls more than 12 m in height (see also table to clauses 1.D.6 and 1.D.35).

1.D.16 Rules of measurement for storeys, walls, panels and building heights

The height of a wall or a *storey* should be measured in accordance with the following diagram.



Key

(a) Measuring storey heights

A is the *ground storey* height if the ground floor is a suspended timber floor or a structurally separate ground floor slab

A 1 is the *ground storey* height if ground floor is a suspended concrete floor bearing on the *external wall*

B is the intermediate *storey* height

B1 is the top *storey* height for walls which do not include a gable

C is the top *storey* height where lateral support is given to gable at both ceiling level and along the roof slope

D is the top *storey* height for walls which include a gable where lateral support is given to the gable only along the roof slope

(b) Measuring wall heights

H 1 is the height of a wall that does not include a gable

H 2 is the height of a *separating wall* which may extend to the under side of the roof

H 3 is the height for a wall (except a *separating wall*) which includes a gable

P is the height of a parapet. If the parapet height is more than 1.2 m add the height to H 1

(c) Measuring building heights

Building heights are measured from the lowest finished ground level to the highest point of the roof

These methods of measurement are unique to SBSG and distinct from schedule 4 to regulation 7.

1.D.17 Wall ties

Wall ties should follow the guidance in BS EN 845-1: 2003 and should be material references 1 or 3 in BS EN 845 Table A1 austenitic stainless steel or non-ferrous ties. Wall ties should be selected in accordance with the following table

Permissible type of cavity wall tie

Normal cavity width (mm) [1]	Tie length (mm) [2]	BS EN 845-1: 2003 tie [4]
50 to 75	220	Types 1, 2, 3 or 4 to DD 140-2 [5] and selected on the basis of the design loading and design cavity width
76 to 90	225	
91 to 100	225 [3]	
101 to 125	250	
126 to 150	275	
151 to 175	300	
176 to 300	[2]	

Notes:

1. Where face insulated blocks are used the cavity width should be measured from the face of the masonry unit.
2. The embedment depth of the tie should be at least 50 mm in both leaves. For cavities wider than 180 mm, calculate the tie length as the structural cavity width plus 125 mm and select the nearest stock length.
3. Double triangle ties having a strength to satisfy Type 2 of DD 140-2 [5] are manufactured. Specialist tie manufacturers should be consulted if 225 mm long double triangle format ties are needed for 91 to 100 mm cavities.
4. Reference should also be made to DD 140-2 [5] for the selection of the type (i.e. types 1, 2, 3 or 4) which will achieve the performance levels given in DD140-2.
5. Although DD 140-2 was withdrawn on 1 February 2005, the tie user classes (types) given in tables 1 and 3 of the latter document can continue to be used after this date.

1.D.18 Brick and block *construction*

Walls should be bonded and put together with mortar. Materials should be chosen from the following list based on their intended use and for the exposure conditions likely to prevail:

a. clay bricks or blocks to BS 3921: 1985 or BS EN 771-1: 2003; or
b. calcium silicate bricks to BS 187: 1978 or BS 6649: 1985; or BS EN 771-2: 2003; or
c. concrete bricks or blocks to BS EN 771-3: 2003 or BS EN 771-4: 2003; or
d. square dressed natural stone should follow the guidance in BS 5628-3: 2006 or BS EN 771-6: 2005; or
e. manufactured stone to BS 6457: 1984 or BS EN 771-5: 2003.

1.D.19 Compressive strength of masonry units

The minimum compressive strengths of masonry units should be derived by obtaining the Condition (A, B or C) from the diagrams to clause 1.D.22 and reading the compressive strength from either the table to clause 1.D.20 or the table to clause 1.D.21.

Where the masonry units have brick dimensions (337.5 mm length x 112.5 mm height) or are blocks, the compressive strengths should be at least the values given in the table to clause 1.D.20.

Where clay and calcium silicate masonry units exceed brick dimensions, the normalised compressive strengths should be at least the values given in the table to clause 1.D.21.

Normalised compressive strengths for block sized clay and calcium silicate masonry units not to brick dimensional format are given in the table to clause 1.D.21.

1.D.20 Compressive strength of masonry units (N/mm^2)

Masonry unit	Clay masonry units to BS EN 771-1: 2003		Calcium silicate masonry units to BS EN 771-2: 2003		Aggregate concrete masonry units to BS EN 771-3: 2003	Autoclaved aerated conc. masonry units to BS EN 771-4: 2003	Manufactured stone masonry units BS EN 771-5: 2003
Condition A[6]							Any unit following the guidance in BS EN 771-5
Brick[3]	Group 1 6.0	Group 2 9.0	Group 1 6.0	Group 2 9.0	6.0	x	
Block[4]	See clause 1.D.21				2.9[7]	2.9	
Condition B[6]							
Brick[3]	Group 1 9.0	Group 2 13.0	Group 1 9.0	Group 2 13.0	9.0	x	
Block[4]	See clause 1.D.21				7.3[7]	7.3	
Condition C[6]							
Brick[3]	Group 1 18.0	Group 2 25.0	Group 1 18.0	Group 2 25.0	18.0	x	
Block[4]	See clause 1.D.21				7.3[7]	7.3	

Notes:

1. This table applies to group 1 and group 2 units.
2. The compressive strengths (N/mm^2) for masonry units described in the BS EN 771 series of standards are mean values.
3. Brick: a masonry unit having work sizes not more than 337.5 mm in length or 112.5 mm in height.
4. Block: a masonry unit more than either of the limiting work sizes of a brick and with a minimum height of 190 mm. For blocks with smaller 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 of at least that shown for block for an inner leaf of a cavity wall in the same position.
5. Group 1 masonry units have not more than 25% formed voids (20% for frogged bricks). Group 2 masonry units have formed voids more than 25%, but not more than 55%.
6. Refer to clause 1.D.22 for locations of Conditions A, B and C.
7. Values marked [7] are dry strengths to BS EN 772-1: 2000.

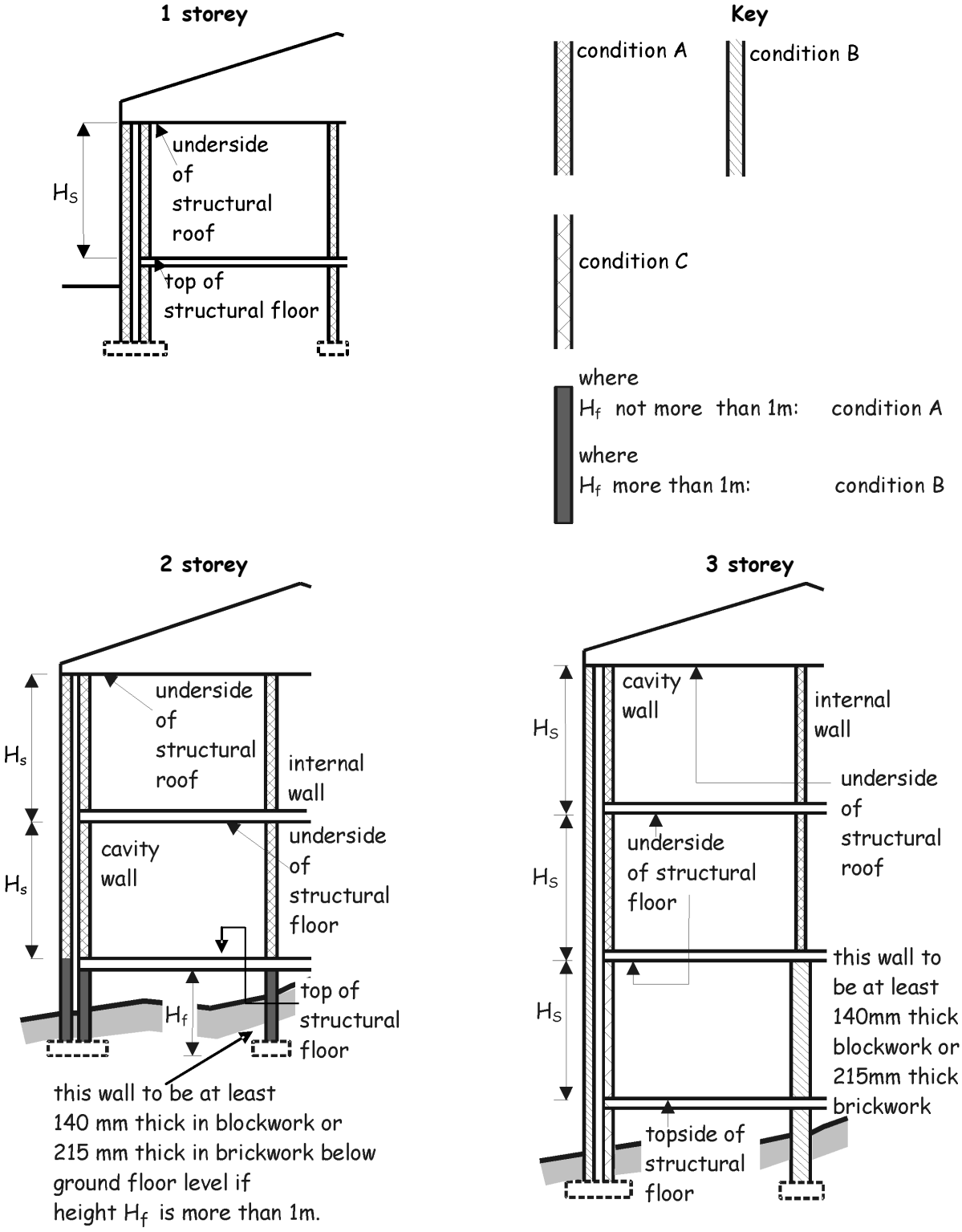
1.D.21 Compressive strength of clay and calcium silicate blocks (N/mm^2)

Standard	Condition	Group 1 masonry units[3]	Group 2 masonry units[4]
Clay masonry units to BS EN 771-1: 2003 and Calcium silicate masonry units to BS EN 771-2: 2003	A	5.0	8.0
	B	7.5	11.0
	C	15.0	21.0

Notes:

1. Values in this table are normalised compressive strengths (N/mm^2). Compressive strengths of masonry units should be derived according to the guidance in BS EN 772-1: 2000.
2. The table applies to clay and calcium silicate block masonry units where the block size is more than 337.5 mm in length or 112.5 mm in height.
3. Group 1 masonry units have not more than 25% formed voids (20% for frogged bricks).
4. Group 2 masonry units have formed voids more than 25%, but not more than 55%.

1.D.22 Compressive strengths of masonry units in walls



Notes:

1. If H_S is not more than 2.7 m, the compressive strength of bricks or blocks should be used in walls as indicated by the key.
2. If H_S is more than 2.7 m, the compressive strength of bricks or blocks used in the wall should be at least Condition B, or as indicated by the key whichever is the greater.
3. If the *external wall* is solid *construction*, the masonry units should have a compressive strength of at least that shown for the internal leaf of a cavity wall in the same position.

4. The guidance in the diagrams for walls of 2 or 3 *storey buildings* should only be used to determine the compressive strength of the masonry units where the roof *construction* is of timber.

1.D.23 Mortar

Mortar should be:

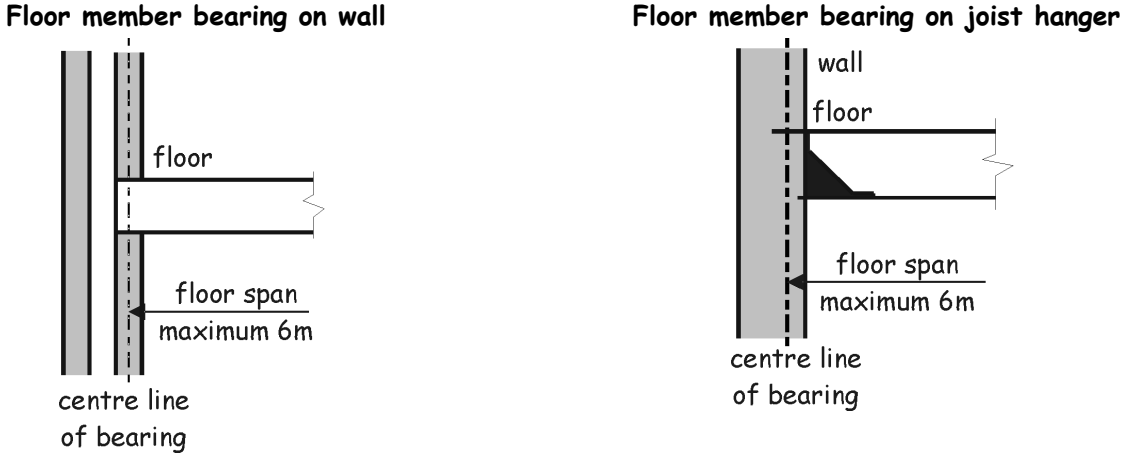
a. Mortar designation (iii) according to BS 5628-3: 2005;
b. Strength class M4 according to BS EN 998-2: 2003;
c. 1:1:5 or 6 CEM 1, lime and fine aggregate measured by volume of dry materials.

1.D.24 Lintels for openings

Proprietary steel or concrete lintels used with masonry cavity wall *construction* should be tested by a *notified body* or justified by calculations.

1.D.25 Maximum span of floors

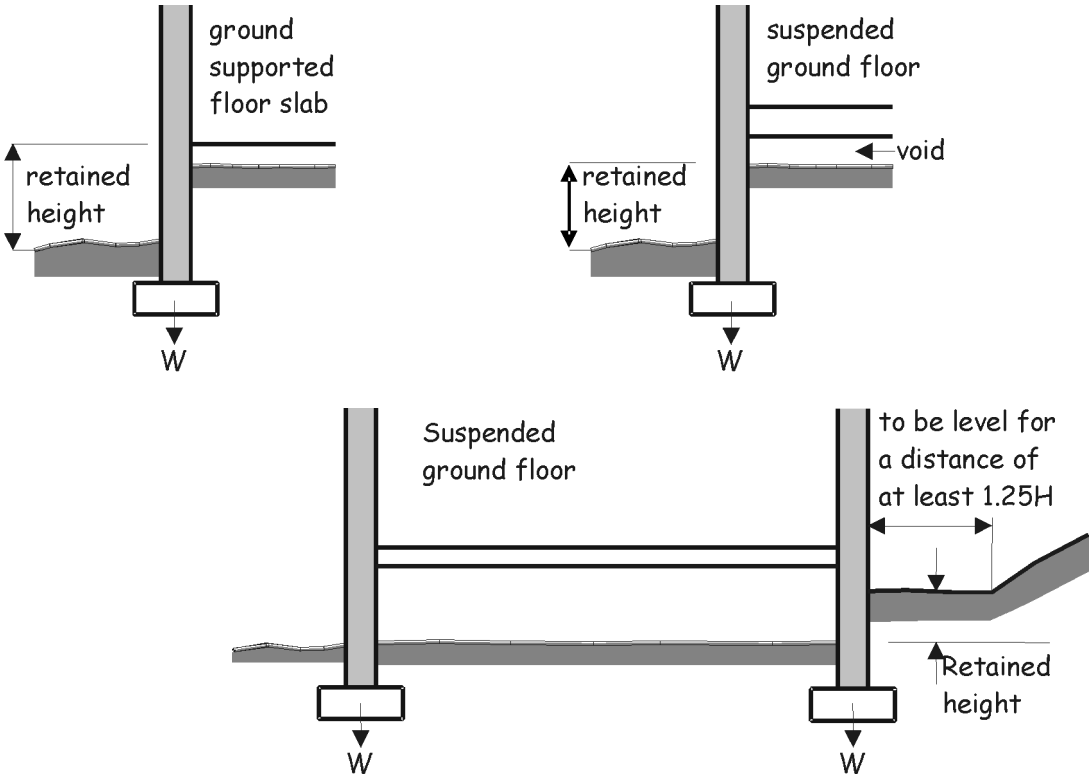
The maximum span for any floor supported by a wall is 6 m, where the span is measured centre to centre of bearing as shown on the diagrams below.



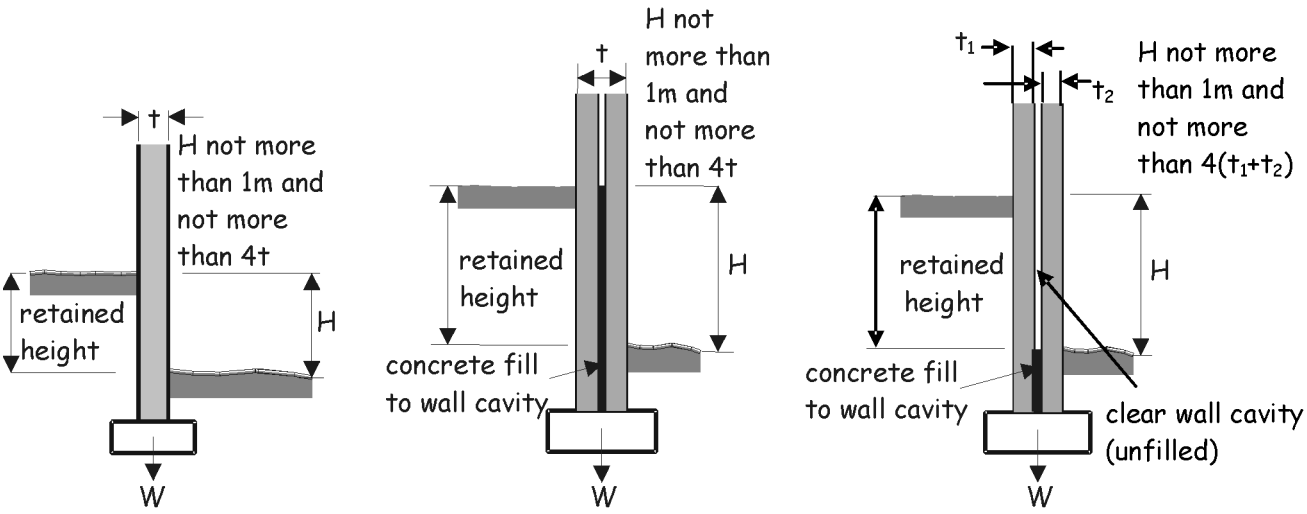
1.D.26 Other loading conditions

a. Vertical loading on walls should be assumed for insitu concrete floor slabs, precast concrete floors and timber floors designed in accordance with annex 1.F and where the bearing length for lintels is at least 150 mm;
b. Where a lintel has a clear span not more than 1.2 m, the bearing length may be reduced to 100 mm;
c. Where lintels carry a concrete floor, the bearing length should be at least 150 mm or $L_s/10$ whichever is the greater, where L_s is the span of the lintel;
d. Differences in level of ground or other solid *construction* between one side of the wall and the other should be not more than four times the thickness of the wall;
e. The combined *dead load* and *imposed load* should be not more than 70 kN/m at the base of wall as shown below provided there is a full *storey* height of masonry above the upper retained level.
f. Walls should not be subject to lateral load other than from wind and that covered by clause 1.D.26b.

a. Examples of ground level differences



b. maximum differences in ground level



Notes:

1. Floor slabs in diagrams b have been omitted for clarity and may be on either side of the walls shown.
2. Cavity walls should be tied in accordance with the table to clause 1.D.17.
3. These recommendations apply only to circumstances where there is a full *storey* height of masonry above the upper retained level.

1.D.27 Vertical lateral restraint to walls

The ends of every wall should be bonded or otherwise securely tied throughout their full height to a buttressing wall, pier or *chimney*. Long walls may be provided with intermediate support dividing the wall into distinct lengths where each distinct length is a supported wall for the purposes of this annex. The buttressing wall, pier or *chimney* should provide support from the base to the full height of the wall.

1.D.28 Criteria for buttressing walls

Buttressing walls are external masonry return walls or internal walls perpendicular to the supported wall.

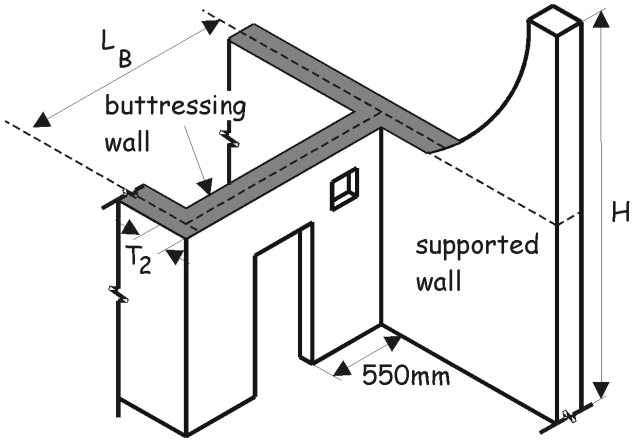
The diagram below gives rules for buttressing walls. Additionally if the buttressing wall is not itself a supported wall, its thickness T_2 should be at least:

a. half the thickness required by this annex for an *external wall* or *separating wall* of similar height and length, less 5 mm; or
b. 75 mm if the wall forms part of a *dwelling* and is not more than 6 m in total height and 10 m in length; or
c. 90 mm in any other case.

Notes:

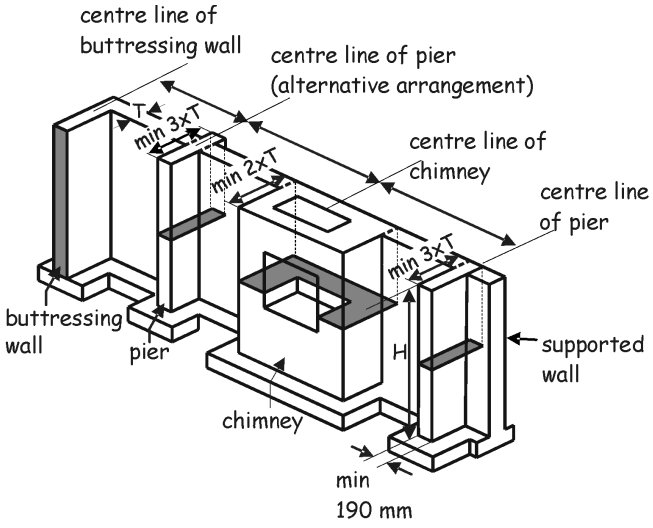
1. The buttressing wall should be bonded or securely tied to the supported wall and at the other end to a buttressing wall, pier or *chimney*.
2. The length, L_B, of the buttressing wall should be at least 1/6 of the overall height, H, of the supported wall.
3. The position and shape of the openings should not impair the lateral support to be given by the buttressing wall.
4. Openings or recesses in the buttressing wall more than 0.1 m^2 should be at least 550 mm from the supported wall.
5. There may be only one opening or recess not more than 0.1 m^2 at any position within 550 mm of the supported wall.
6. The opening height in a buttressing wall should be not more than 0.9 times the floor to ceiling height and the depth of lintel including any masonry over the opening should be not less than 150 mm.
7. Refer to diagram to clause 1.D.16 for measuring the height of the supported wall.

Openings in a buttressing wall



1.D.29 Criteria for piers and chimneys providing restraint

a. Piers should measure at least 3 times the thickness of the supported wall, and *chimneys* twice the thickness, measured at right angles to the wall. Piers should be at least 190 mm wide as shown opposite;
b. The cross-sectional area on plan of *chimneys* (excluding openings for fireplaces) should be at least the area required for a pier in the same wall, and the overall thickness should be at least twice the thickness of the supported wall;
c. The buttressing wall, pier or *chimney* should provide support to the full height of the wall from base to top of wall.



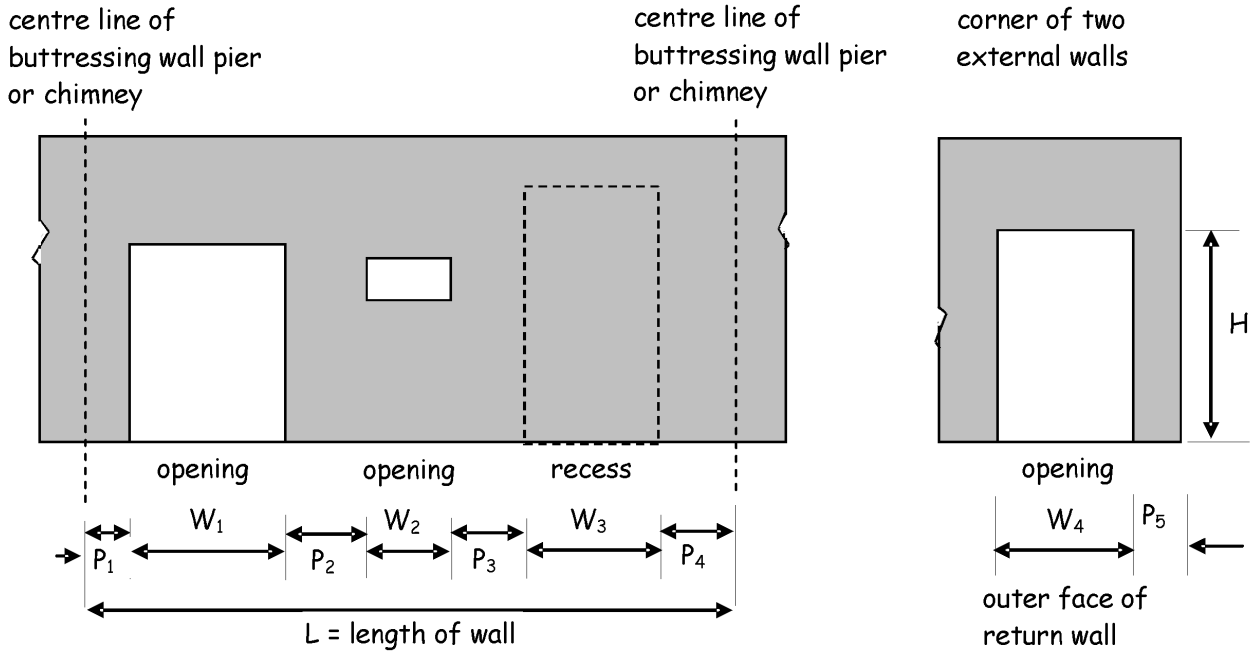
1.D.30 Openings, recesses, chases and overhangs

The number, size and position of openings and recesses should not impair the stability of a wall or the lateral support provided by a buttressing wall to a supported wall. *Construction* over openings and recesses should be supported.

1.D.31 Dimensional criteria

The dimensional criteria are given in the diagram and table below. Openings in walls below ground floor should be limited to small holes for services and ventilation etc. not more than 0.1 m^2 and at least 2 m apart .

1.D.32 Sizes of openings and recesses



Notes:

1. $W_1 + W_2 + W_3$ should be not more than 2L/3
2. None of W_1, W_2 or W_3 should be more than 3 m
3. P_1 should be at least W_1/X
4. P_2 should be at least $(W_1+W_2)/X$
5. P_3 should be at least $(W_2+ W_3)/X$
6. P_4 should be at least W_3/X
7. P_5 should be at least W_4/X but should be at least 665 mm
8. The value of Factor X should be taken from the table below or can be given the value 6, provided the compressive strength of the bricks or blocks (in the case of a cavity wall, in the inner leaf) is not less than 7 N/mm^2.

Value of factor X

Nature of roof span	Max roof span (mm)	Min thickness of inner leaf of wall (m)	Nature of floor span		
			Parallel to wall	Perpendicular to wall, max 4.5 m	Perpendicular to wall, max 6.0 m
Parallel to wall	Non applicable	100	6	6	6
		90	6	6	6
Perpendicular to wall	9	100	6	6	5
		90	6	4	

1.D.33 Chases

Chases should not:
a. if vertical, be deeper than 1/3 of wall thickness or in cavity walls, 1/3 of leaf thickness;
b. if horizontal, be deeper than 1/6 of the thickness of the leaf or wall;
c. be so positioned as to impair the stability of the wall.

Where hollow blocks are used, at least 15 mm thickness of block should be retained.

1.D.34 Overhangs

In *constructing* a corbelled overhang, the amount of any projection should not impair the stability of the wall. Minor overhangs may occur at the interfaces between different masonry materials which have minor differences in thickness provided this does not impair the stability of the wall.

1.D.35 Lateral support by roofs and floors

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

Floors and roofs should:
a. act to transfer lateral forces from walls to buttressing walls, piers or *chimneys*; and
b. be secured to the supported wall by connections specified in clauses 1.D.35-36.

The lateral support of walls at roof and floor levels should follow the guidance in the table below and clauses 1.D.35-36.

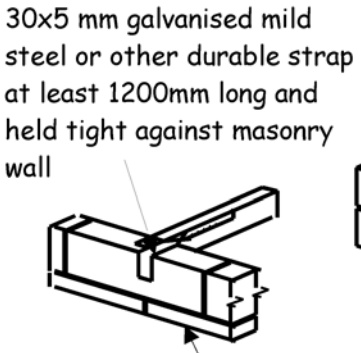
Lateral support of walls

Wall type	Wall length	Lateral support required
Solid or cavity: *external wall* , *separating wall* or *compartment wall*	any length	roof lateral support by every roof forming a junction with the supported wall
	more than 3 m	floor lateral support by every floor forming a junction with the supported wall
Internal load bearing wall (not being a *separating wall* or *compartment wall*)	any length	roof or floor lateral support at the top of each *storey*

Walls should be strapped to floors above ground level by tension straps as shown below to BS EN 845-1: 2003. For corrosion resistance purposes, the tension straps should be material reference 14 or 16.1 or 16.2 (galvanised steel) or other more resistant specifications including material references 1 or 3 (austenitic stainless steel). The declared tensile strength of tension straps should not be less than 8 kN.

The centres of tension straps should be not more than:
a. 2 m for ground and first floors;
b. 1.25 m above first floor level.

Tension strap detail 1

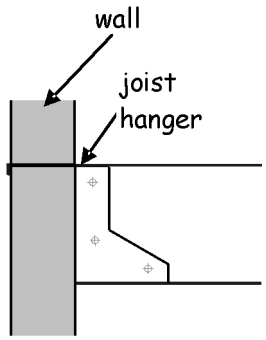


Tension strap detail 2

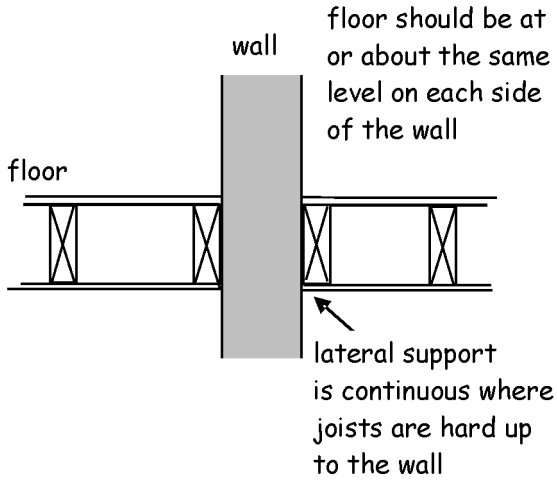
Tension straps need not be provided:

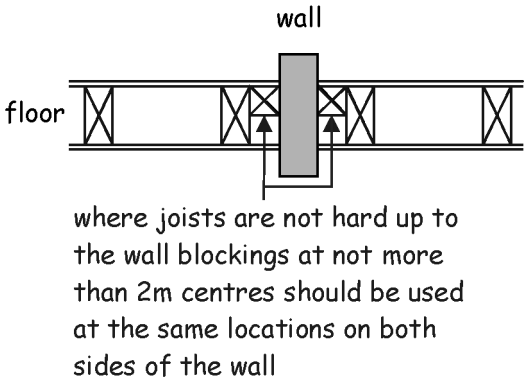
a. in the longitudinal direction of joists in *domestic buildings* of not more than 2 *storeys*, if the joists are at not more than 1.2 m centres and have at least 90 mm bearing on the supported walls or 75 mm bearing on a timber wallplate at each end;
b. in the longitudinal direction of joists in *domestic buildings* of not more than 2 *storeys*, if the joists are carried on the supported wall by joist hangers in accordance with BS EN 845-1: 2003 of the restraint type described in BS 5628-1: 2005 and shown opposite and are incorporated at not more than 2 m centres;
c. where floors are at or about the same level on each side of a supported wall and contact between the floors and wall is either continuous or at intervals not more than 2 m. Where contact is intermittent, the points of contact should be in line or nearly in line on plan as shown on the diagrams below.

Restraint type joist hanger



Restraint of internal walls



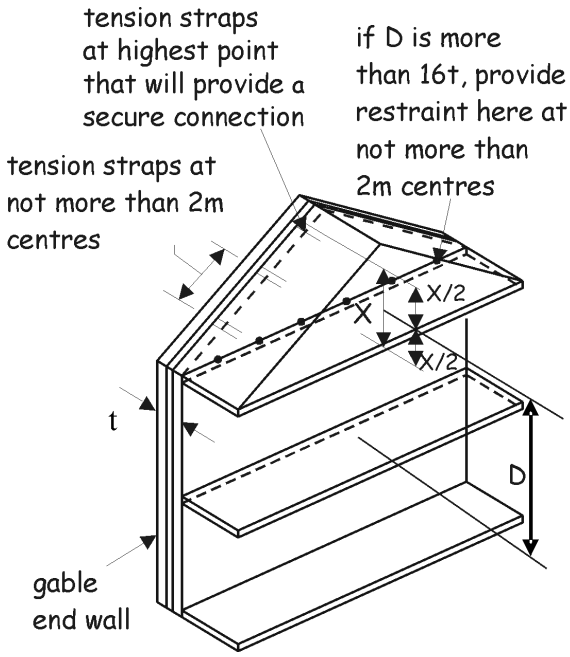


1.D.36 Gable wall strapping

Gable walls should be strapped to roofs by tension straps as shown in the diagram below.

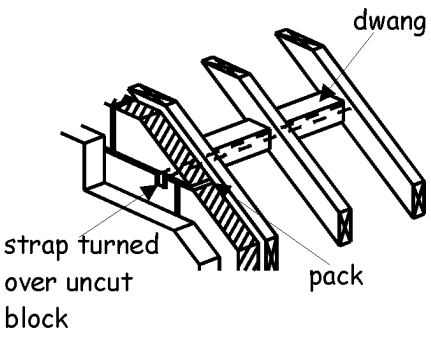
Vertical strapping at least 1 m long should be provided at eaves level at intervals not more than 2 m if the roof:

a. has a pitch of not more than 15^0; and
b. is not tiled or slated; and
c. is not of a type known by local experience to be resistant to wind gusts; and
d. does not have main timber members spanning onto the supported wall at not more than 1.2 m centres.

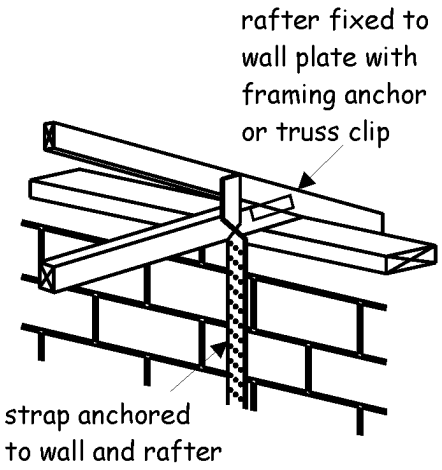


The wall thickness, t = sum of the thicknesses of the leafs + 10 mm.

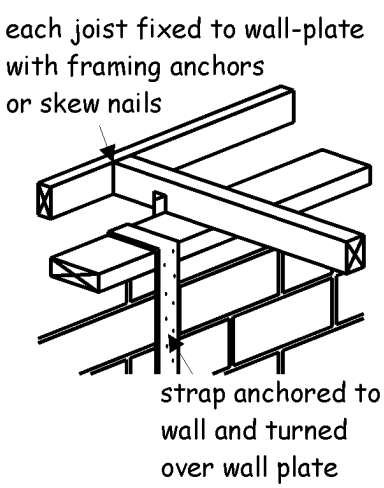
Effective strapping at gable wall



Vertical strapping at eaves of pitched roof



Vertical strapping at eaves of flat roof



1.D.37 Interruption of lateral support

Where a stair or other opening in a floor or roof is alongside a supported wall and interrupts the continuity of lateral support:

a. the length of the opening should be not more than 3 m, measured parallel to the supported wall; and
b. where a connection is provided by means other than by anchor, this should be provided throughout the length of each portion of the wall situated on each side of the opening; and
c. where connection is provided by anchors, these should be spaced at not more than 2 m on each side of the opening to provide the same number of anchors as if there were no opening; and
d. there should be no other interruption of lateral support.

1.D.38 Movement in masonry

Max centres of movement joints

Clay brickwork	12 m	centres
Calcium silicate brickwork	7.5 m	centres
Concrete brickwork and blockwork	6 m	centres

Reference should be made to BS 8103-2: 2005, Annex B which provides general guidance for movement joints.

1.D.39 Small single storey, single leaf buildings

This guidance applies to the following:

- single *storey,* single leaf extensions to *domestic buildings* including garages and outbuildings
- single *storey*, single leaf *buildings* forming a garage or outbuilding within the *curtilage* of a *dwelling*

The guidance is subject to the following limitations:

a. the floor area is not more than 36 m^2; and
b. the walls are solidly *constructed* in brickwork or blockwork using materials which comply with clauses 1.D.17-24; and
c. where the floor area is more than 10 m^2, the walls have a mass of at least 130 kg/m^2 (Note: There is no surface mass limitation recommended for floor areas of not more than 10 m^2); and
d. access to the roof is only for the purposes of maintenance and repair; and
e. the only lateral loads are *wind loads*; and
f. the maximum length or width is not more than 9 m; and.
g. the height of the *building* is not more than the dimensional criteria set out in clause 1.D.2c; and
h. the height of the extension is not more than the dimensional criteria set out in clause 1.D.2b; and

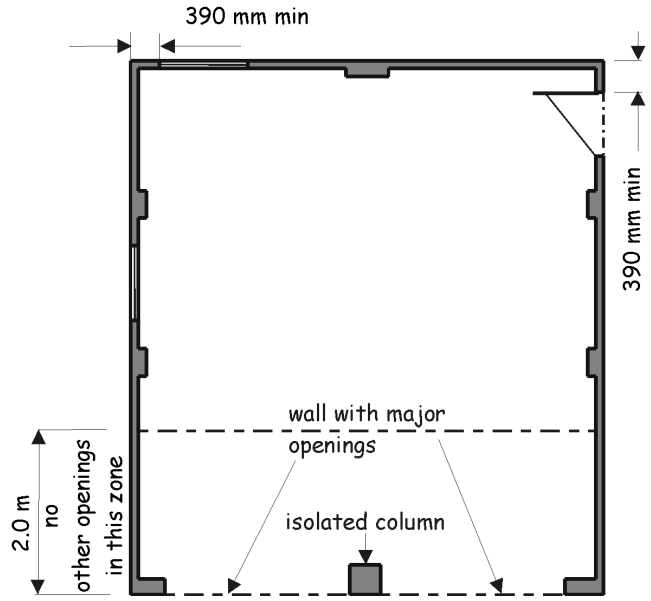
i. the roof is braced at rafter level, horizontally at eaves level and at the base of any gable by roof decking, rigid sarking or diagonal timber bracing, as appropriate, in accordance with the guidance in BS 5268-3: 2006; and
j. walls are tied to the roof structure vertically and horizontally in accordance with clauses 1.D.35-37 and with horizontal lateral restraint at roof level in accordance with clause 1.D.42; and
k. the roof structure of an extension is secured to the structure of the main *building* at both rafter and eaves level.

1.D.40 Size and proportions of openings

Not more than two major openings are permitted in one wall of the *building* or extension where a major opening is defined as not more than 2.1 m in height with a width of not more than 5.0 m for either a single opening or the combined width of two openings.

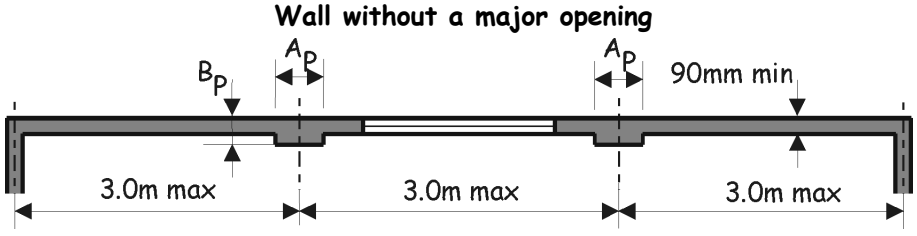
The only other openings permitted in a *building* or extension are for windows and a single leaf door. The size and location of these openings should be in accordance with the diagram opposite and as follows:

a. there should be no other openings within 2.0 m of a wall containing a major opening; and
b. the aggregate size of openings in a wall not containing a major opening should be not more than 2.4 m^2; and
c. there should not be more than 1 opening between piers; and
d. the distance from a window or a door to a corner should be at least 390 mm unless there is a corner pier.

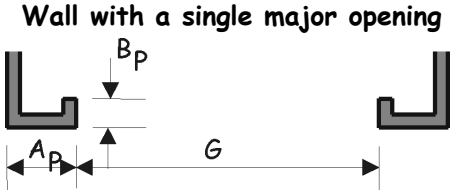


1.D.41 Wall thicknesses and piers

The walls should be at least 90 mm thick. The pier sizes (A_P x B_P) should be at least 390 mm x 190 mm or 327 mm x 215 mm depending on the size of the masonry units. Isolated columns should be at least 325 mm x 325 mm (C_C x C_C). Walls which do not contain a major opening but are more 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 the diagram below.



Walls which contain 1 or 2 major openings should, in addition, have piers oriented as shown in the diagrams above, opposite and below. Where ties are used to connect piers to walls they should be flat, 20 mm x 3 mm in cross

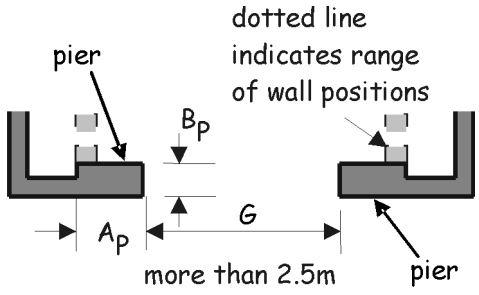


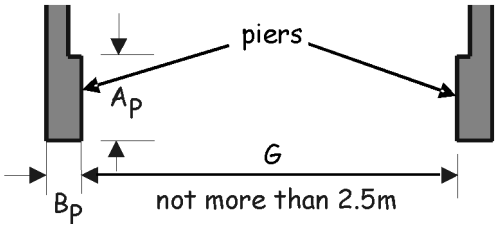
section in accordance with clause 1.D.17, be placed in pairs and be spaced at not more than 300 mm centres vertically.

Key

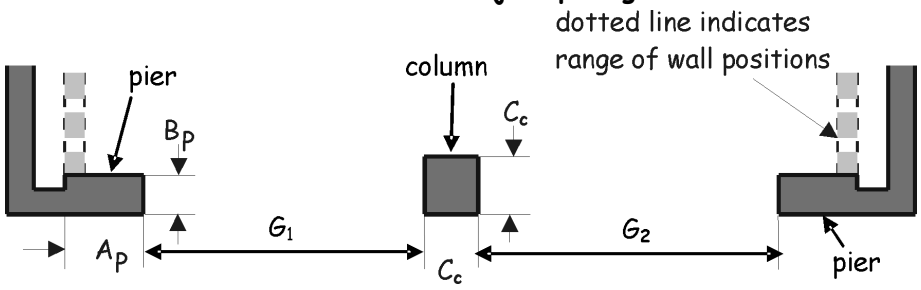
G	Structural opening width
A_p	Pier width
B_p	Pier depth
C_c	Column width and depth

For walls with one or two major openings as shown below :
G_1 or G_2 or $G_1 + G_2$ should be not more than 5 m.



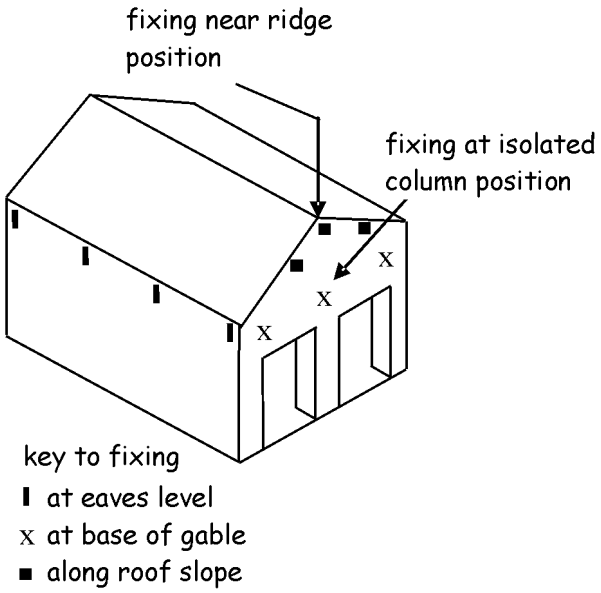


Wall with two major openings



1.D.42 Horizontal lateral restraint at roof level

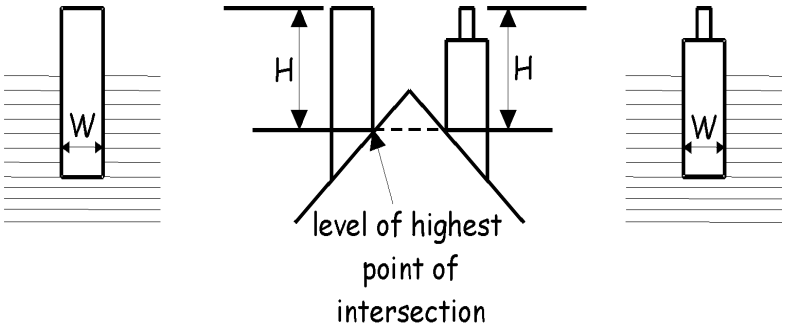
Walls should be tied horizontally to the roof structure at not more than 2 m centres with straps fixed in accordance with clauses 1.D.35-36. Where straps cannot pass through a wall they should be secured to the masonry using fixings and isolated columns should also be tied to the roof structure all as shown.



1.D.43 Proportions for masonry chimneys

Where a *chimney* is not supported by ties or securely restrained, its height, H, should be not more than 4.5 x W where:

- W is the least horizontal dimension of the *chimney* measured at the same point of intersection; and
- H is measured to the top of any *chimney* pot or other *flue* terminal from the highest point of intersection with the roof surface, gutter, etc.;
- the density of the masonry is more than 1500 kg/m^3.



Annex

1.E Timber frame walls

1.E.0 Introduction

Small timber frame *buildings* can be designed to take into account loading conditions, limitations on dimensions, openings, subject to restraint conditions.

The guidance for timber frame *construction* has been produced for use by those who have expertise in *building* design and *construction* but not necessarily in structural engineering design. Where the conditions or parameters fall outside the scope then specialist advice should be sought from chartered engineers or other appropriately qualified persons.

This guidance is based on the platform frame method of timber frame *construction* with external masonry cladding being the most common form of timber frame *construction* in Scotland. This consists of full height timber wall panels for each *storey* built on to the floor below with intermediate floors built on top of the wall panels. The roof is *constructed* on top of the top *storey* wall panels with the masonry cladding connected to the timber panels by wall ties.

It should be noted that the guidance within this annex only relates to section 1: Structure. There are other factors such as *cavity barriers*, breather membranes, thermal insulation, etc. which may be relevant and reference should be made to the Technical Handbooks.

This annex provides guidance for timber frame wall *construction* for *domestic buildings* of not more than 2 *storeys* where loading criteria for individual floors does not exceed those given in clause 1.E.5 and the total limit of loading does not exceed that given in clause 1.E.42.

There is guidance in annex 1.D: masonry walls which is relevant to this annex with respect to masonry cladding to timber frame walls.

1.E.1 Explanation of terms

The following terms are used in addition to the definitions and explanations in Appendix A of the Technical Handbooks

Composite action means where a timber frame wall acts together with other materials such as masonry cladding, sheathing or lining.

Cripple stud means the vertical member in a timber framed partition or wall which supports a lintel.

Racking resistance means the ability of a partition or wall panel to resist *wind loads* in the plane of the panel.

Timber frame wall means a wall *constructed* of timber studs acting as framing members, bracing and wall sheathing.

Wall sheathing means a manufactured sheet which is used to provide the wall panel stiffness to resist *wind loads*.

1.E.2 Wall types

This annex only provides guidance for the types of wall extending to full *storey* height for *domestic buildings* restricted to *houses* of not more than 2 *storeys* as follows:

- *external walls*
- internal load bearing walls
- *separating walls*

This annex should be used in conjunction with annexe 1.B; and

a. if a timber wall structure is designed in accordance with the guidance in annex 1.E, all the design conditions in this annex should be satisfied;
b. walls should comply with the relevant recommendations of BS 5268-6.1: 1996, except regarding the conditions given in this annex ;
c. *buildings* should be rectangular or square shape in plan;
d. in formulating the guidance of this annex, the worst combination of circumstances likely to arise was taken into account;
e. if a recommendation of this annex is considered too onerous in a particular case then adequacy by calculation should be shown in respect of the aspect of the wall which is subject to the departure

rather than for the entire wall;

f. the guidance given in this annex is based upon the material strengths of timber, sheathing, plasterboard and masonry being not less than that indicated in clauses 1.E.28-40;
g. roof *construction* should be:
   - duo or mono pitch trussed rafters with 15-45 $^{\circ}$ pitch and *dead load* not more than 1.04 kN/m ^{2} on the slope;
   - or *flat roofs* , raised tie or collared roofs in accordance with guidance in annex 1.F.
h. floor *dead load* should be not more than 0.5 kN/m^2;
i. internal, party and *external wall dead loads* should be not more than 1.5 kN/m excluding masonry cladding;
j. panel heights should be not more than 2.7 m;
k. timber frame walls should act compositely with the masonry cladding, sheathing and inner plasterboard lining all contributing to the racking resistance.

The scope of this annex excludes *buildings* with point loads (e.g. from hipped ends to roofs with girder trusses and other types of cladding such as timber).

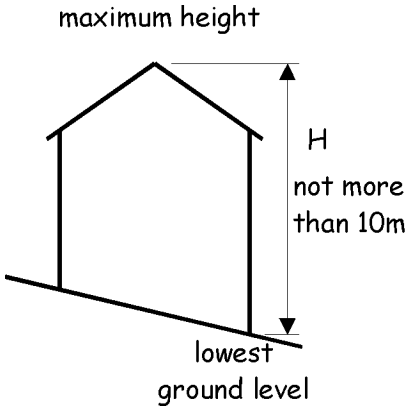
Where point loads onto walls are required, specialist advice should be sought from chartered engineers or other appropriately qualified persons.

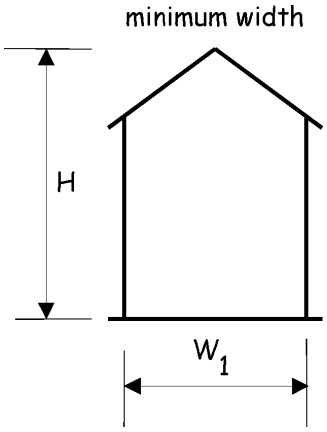
Wall sheathing which provides the racking resistance to *wind loading* generally is the limiting factor and this aspect should be checked prior to carrying out the remainder of the design. It is unlikely that this guidance could be used with walls with openings more than 30% of the total wall area or for front gable *buildings* where there are large openings in the shorter length walls.

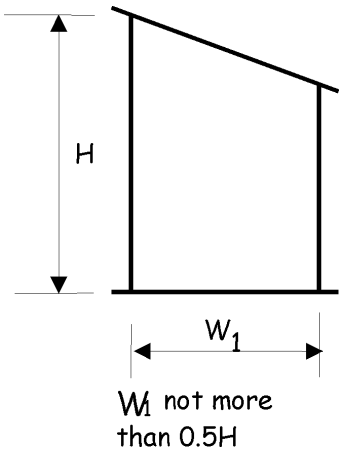
1.E.3 Conditions relating to the building of which the walls forms part

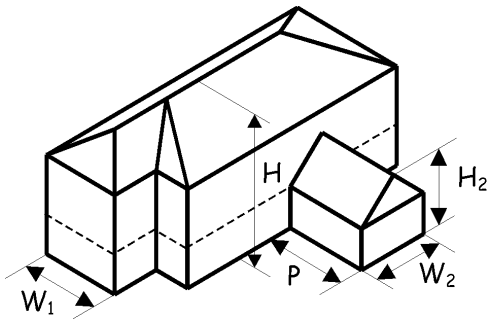
This annex applies only to *buildings* having proportions within the following limits and as shown on the diagrams below, subject to the limits of clause 1.E.26:

a. the maximum height, H, of the *building* measured from the lowest finished ground level adjoining the *building* to the highest point of any wall or roof must not be more than:
   - 10 m for duo pitch roofs *;*
   - 5.5 m for mono pitch or *flat roofs.*
b. the height of the *building*, H, should not be more than twice the least width of the *building,* W_1;
c. the height of the wing, H_2, should not be more than twice the least width of the wing, W_2, when the projection, P, is more than twice the width, W_2.





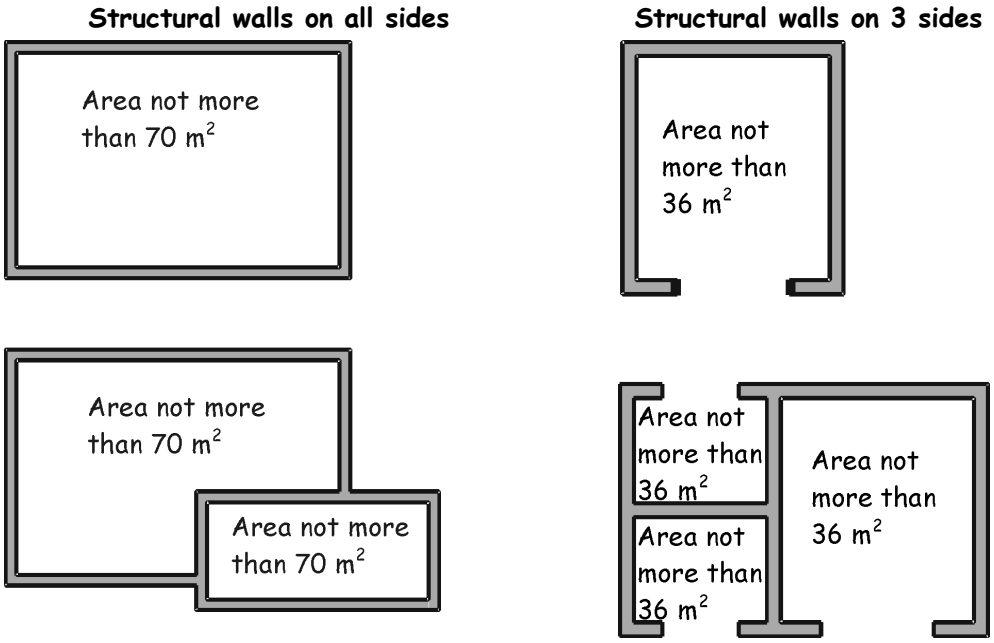




1.E.4 Maximum floor area

The guidance in this annex applies where:

- the areas of floors enclosed by structural walls on all sides are not more than 70 m^2;
- the areas of floors without a structural wall on one side are not more than 36 m^2;
- the openings are not more than set out in clause 1.E.17;
- the number of areas of floors as above which can be connected together should be not more than 4.



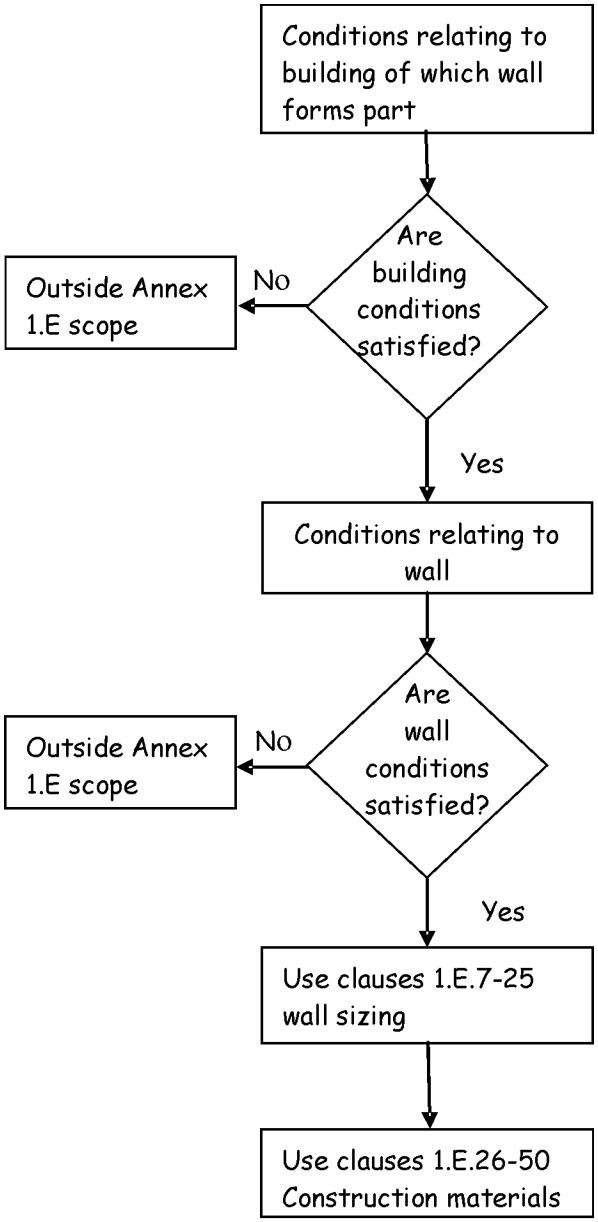
1.E.5 Imposed loads on roofs, floors and ceilings

The *imposed loads* on roofs, floors and ceilings should not exceed those given in the table below.

Element	Loading	
Roof	distributed load	1.00 kN/m^2 for spans up to 12 m 1.50 kN/m^2 for spans up to 6 m
Floors	distributed load	2.00 kN/m^2 together with a concentrated load of 1.4 kN
Ceilings	distributed load	0.25 kN/m^2 together with concentrated load of 0.9 kN

1.E.6 Wall structure

Wall structure should be determined according to this annex provided the following conditions are met:



Building Conditions

limitations on size and proportions of *building* (clause 1.E.3);
max allowable floor areas (clause 1.E.4);
max *imposed loads* and *wind loads* (clause 1.E.13).

Wall Conditions

max allowable length and height of wall (clause 1.E.26);
construction materials (clauses 1.E.28-40);
loading on walls (clauses 1.E.41-42);
end restraints (clause 1.E.43);
openings, notching and drilling (clauses 1.E.44-48);
lateral support by floors and roofs (clause 1.E.49);
differential movement (clause 1.E.50).

1.E.7 Minimum thicknesses of external cavity walls

Masonry clad, timber frame walls should comprise masonry cladding at least 100 mm thick, 50 mm nominal cavity width, 9 mm nominal sheathing thickness and timber studs at least 89 mm depth and inner wall lining. Wall ties should be nailed to the vertical studs and not to the sheathing at the following centres:

a. brickwork cladding: horizontal centres of 600 mm and vertical centres of 375 mm;
b. blockwork cladding: horizontal centres of 400 or 600 mm and vertical centres of 450 mm;
c. wall ties should also be provided, at not more than 300 mm centres vertically, within a distance of 225 mm from the vertical edges of all openings, movement joints and roof verges;
d. in exposed wind locations, the tie density would require to be increased in accordance with BS 5268-6.1: 1996;
e. for cavity wall ties refer to clause 1.E.29.

1.E.8 Walls providing vertical support to other walls

Irrespective of the materials used, a wall should not be less in thickness than any part of the wall to which it gives vertical support.

1.E.9 Timber frame wall sizing

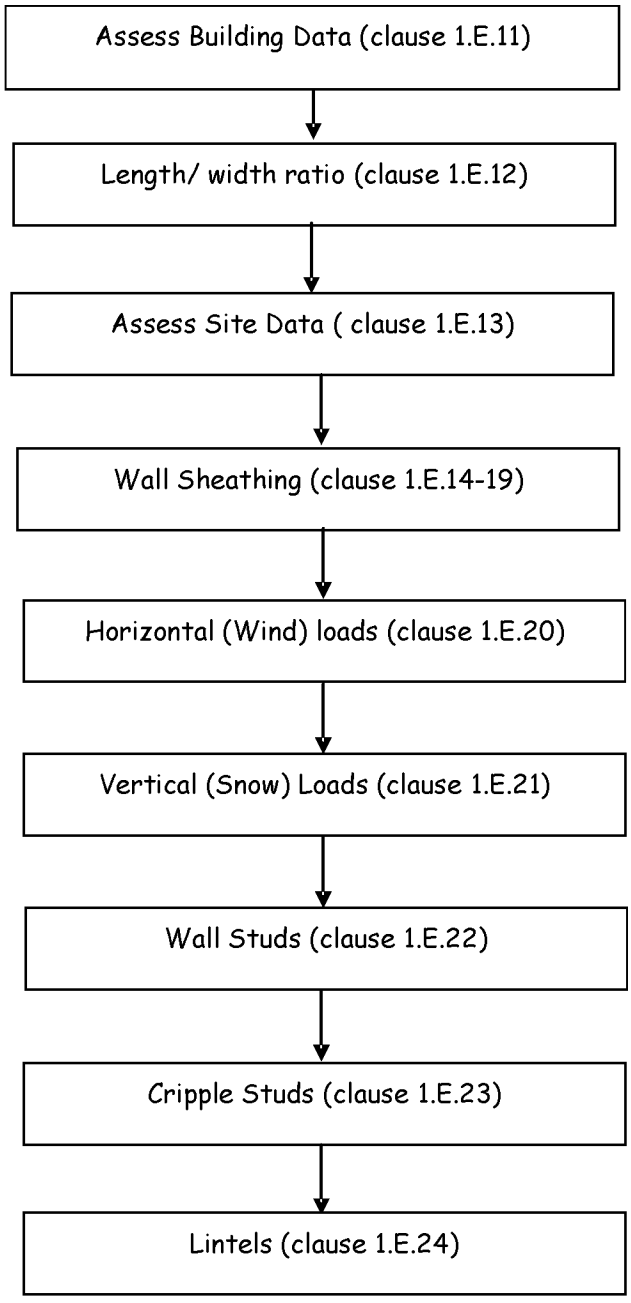
Timber frame walls consist of vertical timber studs nailed to bottom and top rails to which plywood or OSB sheathing is nailed. Wall panels are nailed to each other, to floors below and above and the roof. Plasterboard is nailed or screwed to the studs as the internal wall lining. Openings for doors and windows are formed by additional vertical cripple studs at the open edges supporting timber lintels.

The timber frame walls are the load bearing parts of the walls and the individual parts act as follows:

- sheathing resists the *wind loads* which act on the walls facing the wind while the walls at right angles support these walls by means of the racking resistance of the sheathing (called racking or wind walls);
- walls studs support the vertical loads (snow, floor loads and self weight of the roof, floors and upper timber floors) and *wind loads*;
- cripple studs and lintels frame openings carrying the loads to the floor below;
- floors and roofs support the walls horizontally top and bottom;
- walls, roofs and floors act compositely as a robust 3 dimensional structural box giving overall stability to the *building*;
- masonry cladding provides secondary support to the sheathing;
- internal walls can give additional racking resistance provided they are sheathed in plywood or OSB rather than plasterboard.

The procedure which should be followed to determine the member sizing for timber frame wall *construction* is summarised in the flow chart opposite and explained in detail thereafter together with a worked example in clause 1.E.25.

Design Procedure Flow Chart

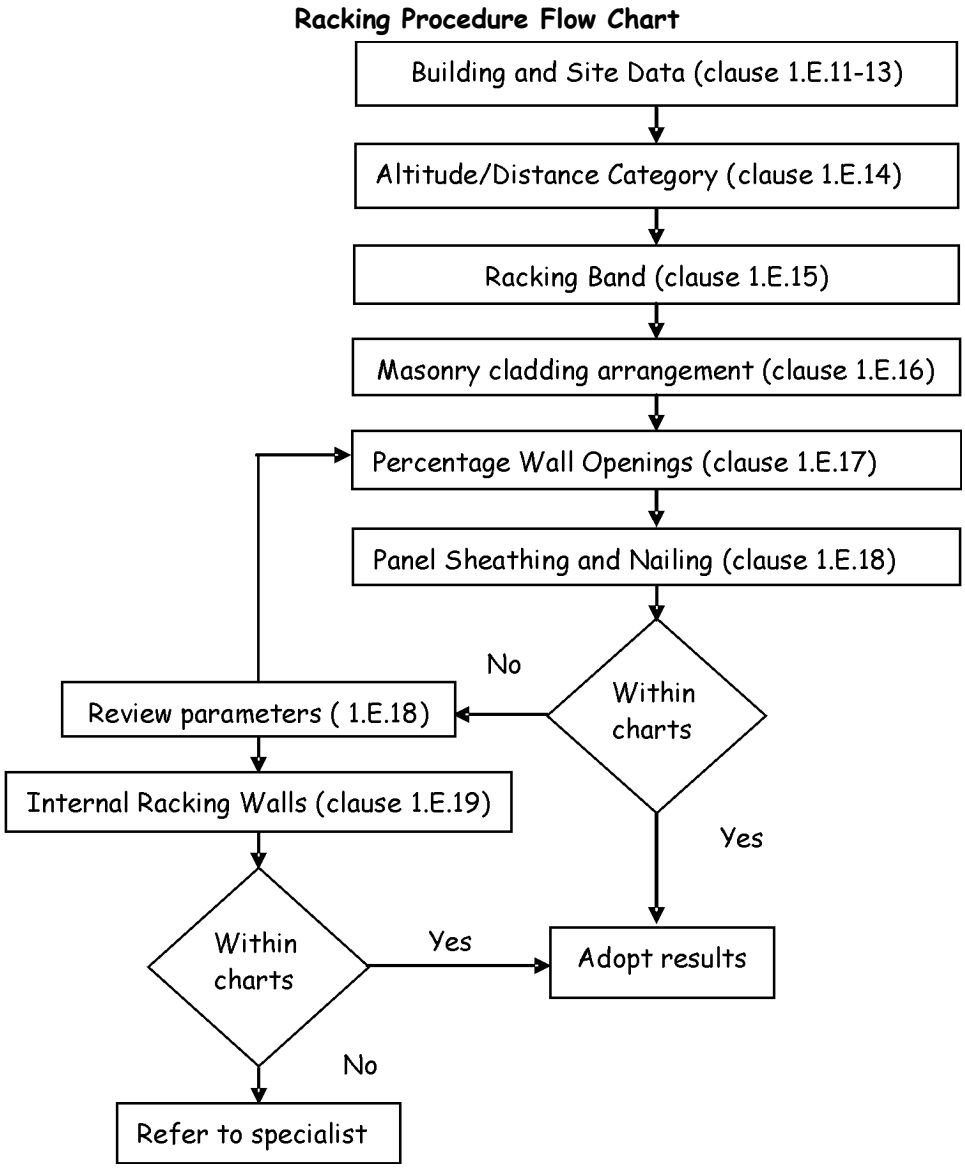


1.E.10 Wall sheathing

The *wind loads* are resisted and transferred to the base of the walls by the racking resistance of the racking (or wind) wall panels. This is achieved by the sheathing to the *external wall* panels although internal walls can also be used in certain circumstances.

Walls should only be considered to be racking walls and hence able to provide resistance to *wind loads* if they are designed in accordance with the following racking procedure and have at least one layer of plywood sheathing or OSB secured to the timber studs.

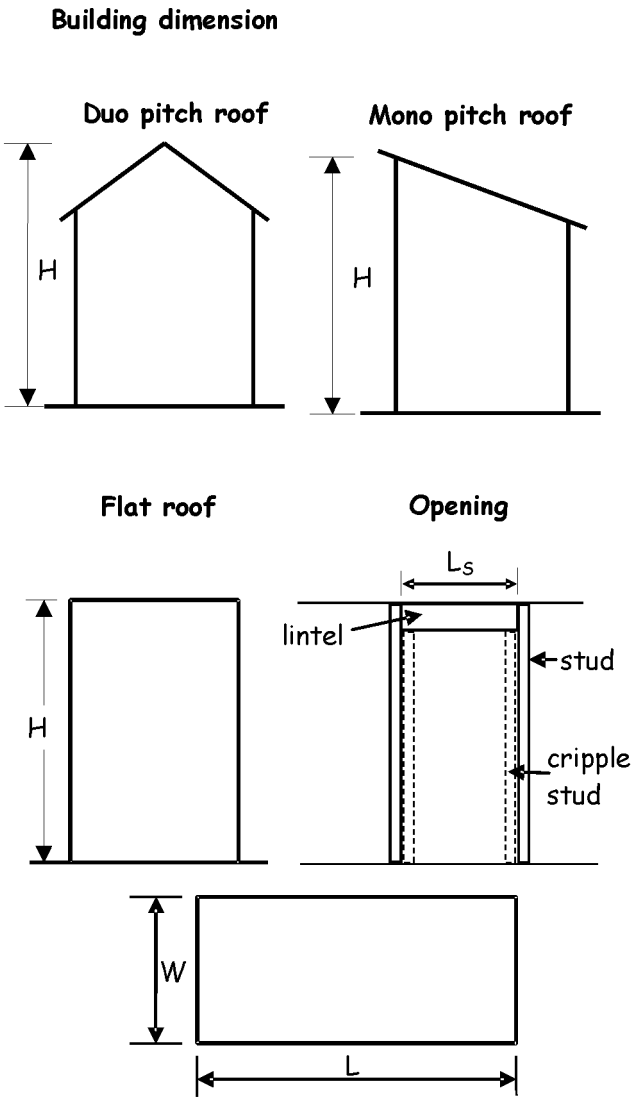
The flow chart below and the clauses referenced provide guidance on how to provide racking resistance.



1.E.11 Building data

Establish the following dimensions for the *building*:

- overall outside plan width of the *building*, W;
- overall outside plan length of the *building*, L;
- overall *building* height from ground level to ridge, H;
- panel height from underside of bottom rail to top of top rail, H;
- number of *storeys*;
- roof shape: duopitch, monopitch or flat;
- spans of roof and floors;
- lintel clear span, L_s.



Note that the height should be measured from the lowest finished ground level adjoining the *building* to the highest point of any wall or roof.

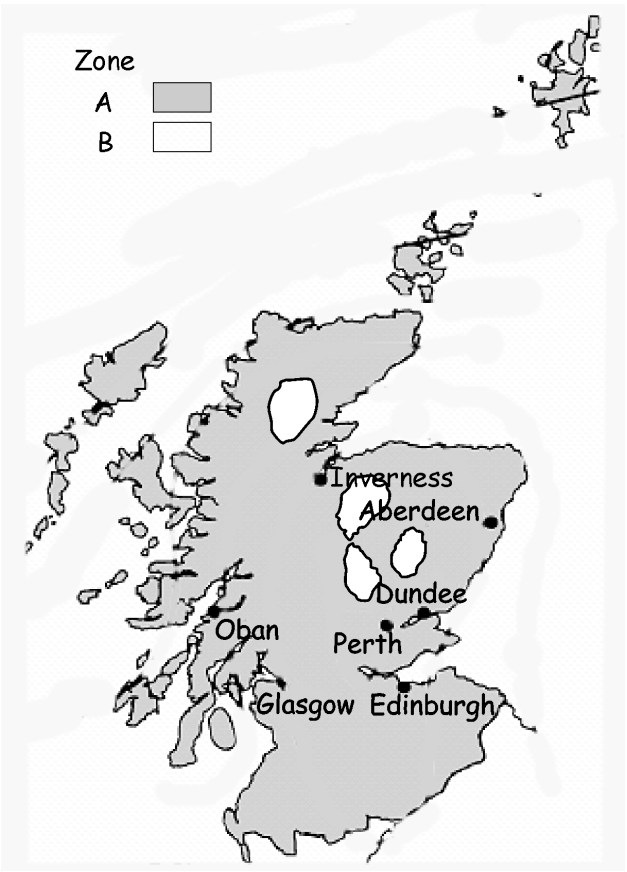
1.E.12 Length/width ratio

Determine the length/width ratio of the *building* plan area, $\beta=L/W$, where β should always be rounded up from the derived value to the nearest 0.5 and should not be less than 1.0. It is best practice to keep β as close to 1.0 as possible.

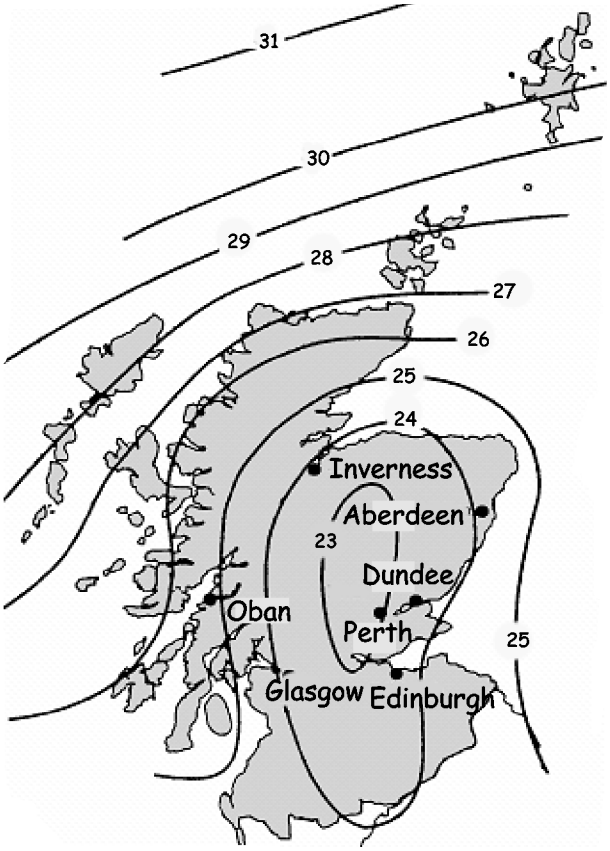
1.E.13 Site data

a. determine the *site* location of the *building*;
b. establish the distance of the *site* to the coast . (Where a *site* is nearer than 1 km to an inland area of water which extends more than 1 km in the wind direction, the distance to the coast should be taken as from the edge of the water);
c. establish the altitude of the *site* above ordinance datum;
d. establish the snow zone as A or B from the snow map below;
e. establish the wind speed from the wind speed map below.

Snow zone map



Wind speed map (m/sec)



1.E.14 Altitude/distance category

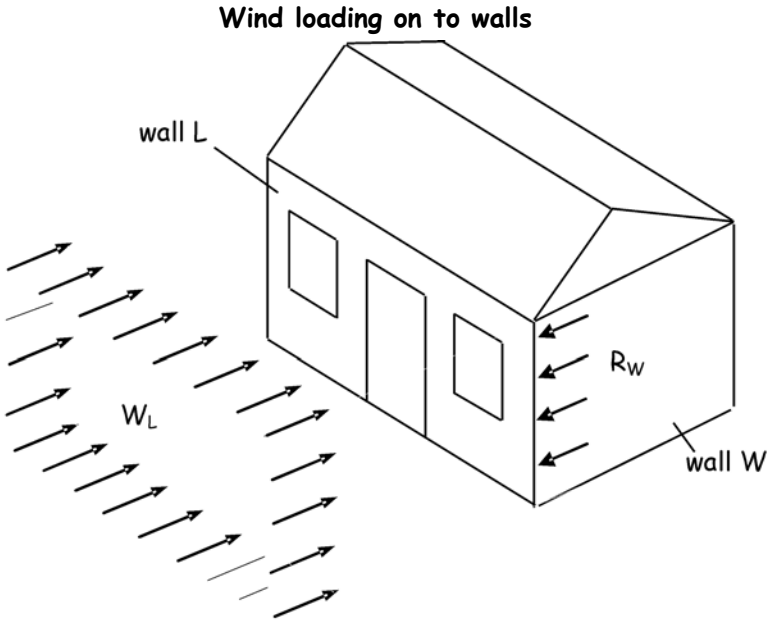
Using the *site* altitude and distance to the coast, read the altitude/distance category (AD1-AD6) from the table opposite.

Table Altitude/distance category

Altitude (m)	Distance to the coast (km)	
	≤ 10	≤ 100
0	AD1	AD1
≤ 50	AD1	AD1
≤ 100	AD2	AD2
≤ 150	AD3	AD3
≤ 200	AD4	AD3
≤ 300	AD5	AD5
≤ 400	AD6	AD6

1.E.15 Racking loads

The *wind load* on an *external wall* is supported by the racking resistance of the *external walls* perpendicular to that wall. The racking resistance of the perpendicular walls are 50% of the *wind load* as shown in the diagrams below.



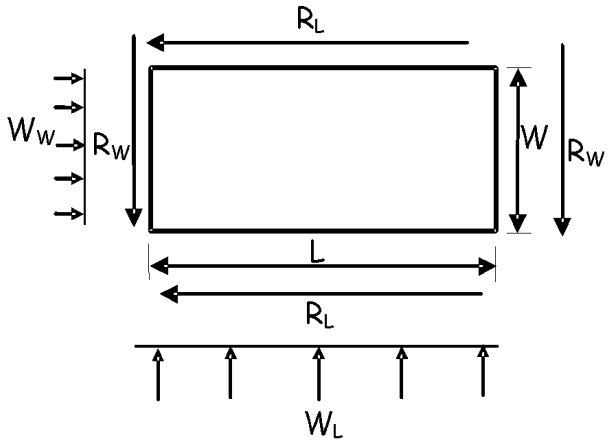
Key

W_L: *wind load* on to long wall, L

W_W: *wind load* on to short wall, W

R_W: racking resistance from wall W, supporting 50% of the total *wind load* , W_L , on wall L

R_L racking resistance from wall L supporting 50% of the total *wind load* , W_W , on wall W



The racking resistance, R, which each wall should provide should be read from the following tables using the information derived above:

- overall *building* height from ground level to ridge, H;
- roof shape from clause 1.E.11;
- length/width ratio, β from clause 1.E.12;
- wind speed from clause 1.E.13;
- altitude/ distance category, AD, from clause 1.E.14.

Tables 1-4 provide racking resistance for duo pitch roofed *buildings* for overall heights, H of 5.5 and 10 m for wind speeds of 23-30 m/sec;

Tables 5-8 provide racking resistance for mono pitch roofed *buildings* for overall heights, H of 5.5 m for wind speeds of 23-30 m/sec;

Tables 9-12 provide racking resistance for *flat roofed buildings* for overall heights, H of 5.5 m for wind speeds of 23-30 m/sec.

Racking resistance for duo pitch roofs

Table 1 Wind speed = 23 m/sec

β	Side	H = 5.5 m						H = 10.0 m					
		Altitude/distance category (AD)						Altitude/distance category (AD)					
		AD1	AD2	AD3	AD4	AD5	AD6	AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R1	R2	R2	R2	R2	R2	R3	R3	R4	R5	R6	R7
	L	R1	R1	R2	R2	R2	R2	R4	R4	R5	R5	R6	R7
1.5	W	R3	R3	R4	R4	R5	R5	R8	R9	R9	R11	R11	x
	L	R1	R1	R1	R1	R1	R2	R3	R3	R3	R4	R4	x
2.0	W	R4	R5	R5	R6	R7	R7	R11	R11	x	x	x	x
	L	R1	R1	R1	R1	R1	R1	R2	R2	x	x	x	x
2.5	W	R5	R6	R6	R7	R8	R9	x	x	x	x	x	x
	L	R1	R1	R1	R1	R1	R1	x	x	x	x	x	x
3.0	W	R6	R7	R7	R8	R9	R11	x	x	x	x	x	x
	L	R1	R1	R1	R1	R1	R1	x	x	x	x	x	x
3.5	W	R7	R7	R8	R9	R11	R11	x	x	x	x	x	x
	L	R1	R1	R1	R1	R1	R1	x	x	x	x	x	x

Table 2 Wind speed = 25 m/sec

β	Side	H = 5.5 m						H = 10.0 m					
		Altitude/distance category (AD)						Altitude/distance category (AD)					
		AD1	AD2	AD3	AD4	AD5	AD6	AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R2	R2	R2	R2	R3	R3	R4	R4	R5	R6	R7	R9
	L	R2	R2	R2	R2	R3	R3	R5	R5	R6	R7	R7	R8
1.5	W	R4	R4	R5	R5	R6	R7	R11	R11	R11	x	x	x
	L	R1	R1	R1	R2	R2	R2	R3	R4	R4	x	x	x
2.0	W	R5	R6	R7	R7	R8	R9	x	x	x	x	x	x
	L	R1	R1	R1	R1	R1	R1	x	x	x	x	x	x
2.5	W	R7	R7	R8	R9	R11	R11	x	x	x	x	x	x
	L	R1	R1	R1	R1	R1	R1	x	x	x	x	x	x
3.0	W	R8	R8	R9	R11	R11	R11	x	x	x	x	x	x
	L	R1	R1	R1	R1	R1	R1	x	x	x	x	x	x
3.5	W	R8	R9	R11	R11	R11	x	x	x	x	x	x	x
	L	R1	R1	R1	R1	R1	x	x	x	x	x	x	x

Racking resistance for duo pitch roofs

Table 3 Wind speed = 27 m/sec

β	Side	H = 5.5 m						H = 10.0 m					
		Altitude/distance category (AD)						Altitude/distance category (AD)					
		AD1	AD2	AD3	AD4	AD5	AD6	AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R2	R2	R3	R3	R3	R4	R4	R5	R6	R7	R9	R11
	L	R2	R2	R2	R3	R3	R3	R6	R6	R7	R8	R9	R11
1.5	W	R5	R5	R6	R6	R7	R8	R11	R11	x	x	x	x
	L	R1	R2	R2	R2	R2	R2	R4	R5	x	x	x	x
2.0	W	R7	R7	R8	R9	R11	R11	x	x	x	x	x	x
	L	R1	R1	R1	R1	R2	R2	x	x	x	x	x	x
2.5	W	R8	R9	R11	R11	R11	x	x	x	x	x	x	x
	L	R1	R1	R1	R1	R1	x	x	x	x	x	x	x
3.0	W	R9	R11	R11	R11	x	x	x	x	x	x	x	x
	L	R1	R1	R1	R1	x	x	x	x	x	x	x	x
3.5	W	R11	R11	R11	x	x	x	x	x	x	x	x	x
	L	R1	R1	R1	x	x	x	x	x	x	x	x	x

Table 4 Wind speed = 30 m/sec

β	Side	H = 5.5 m						H = 10.0 m					
		Altitude/distance category (AD)						Altitude/distance category (AD)					
		AD1	AD2	AD3	AD4	AD5	AD6	AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R3	R3	R3	R4	R4	R5	R5	R6	R8	R9	R11	x
	L	R3	R3	R3	R3	R4	R4	R7	R8	R9	R11	R11	x
1.5	W	R6	R6	R7	R8	R9	R11	x	x	x	x	x	x
	L	R2	R2	R2	R3	R3	R3	x	x	x	x	x	x
2.0	W	R8	R9	R11	R11	R11	x	x	x	x	x	x	x
	L	R1	R1	R2	R2	R2	x	x	x	x	x	x	x
2.5	W	R11	R11	R11	x	x	x	x	x	x	x	x	x
	L	R1	R1	R1	x	x	x	x	x	x	x	x	x
3.0	W	R11	R11	x	x	x	x	x	x	x	x	x	x
	L	R1	R1	x	x	x	x	x	x	x	x	x	x
3.5	W	R11	x	x	x	x	x	x	x	x	x	x	x
	L	R1	x	x	x	x	x	x	x	x	x	x	x

Racking resistance for monopitch roofs

Table 5 Wind Speed = 23 m/sec

β	Side	H = 5.5 m					
		Altitude/distance category (AD)					
		AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R3	R3	R3	R4	R4	R5
	L	R1	R1	R2	R2	R2	R2
1.5	W	R5	R6	R6	R7	R8	R9
	L	R1	R1	R1	R1	R1	R2
2.0	W	R7	R8	R9	R10	R11	R11
	L	R1	R1	R1	R1	R1	R1
2.5	W	R9	R9	R10	R11	x	x
	L	R1	R1	R1	R1	x	x
3.0	W	R10	R11	R11	x	x	x
	L	R1	R1	R1	x	x	x
3.5	W	R11	R11	x	x	x	x
	L	R1	R1	x	x	x	x

Table 6 Wind Speed = 25 m/sec

β	Side	H = 5.5 m					
		Altitude/distance category (AD)					
		AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R3	R4	R4	R5	R5	R6
	L	R2	R2	R2	R2	R3	R3
1.5	W	R7	R7	R8	R9	R10	R11
	L	R1	R1	R1	R2	R2	R2
2.0	W	R9	R10	R11	R11	x	x
	L	R1	R1	R1	R1	x	x
2.5	W	R11	R11	x	x	x	x
	L	R1	R1	x	x	x	x
3.0	W	R11	x	x	x	x	x
	L	R1	x	x	x	x	x
3.5	W	x	x	x	x	x	x
	L	x	x	x	x	x	x

Table 7 Wind Speed = 27m/sec

β	Side	H = 5.5 m					
		Altitude/distance category (AD)					
		AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R4	R5	R5	R6	R6	R7
	L	R2	R2	R3	R3	R3	R3
1.5	W	R8	R9	R9	R10	R11	x
	L	R1	R2	R2	R2	R2	x
2.0	W	R11	R11	x	x	x	x
	L	R1	R1	x	x	x	x
2.5	W	x	x	x	x	x	x
	L	x	x	x	x	x	x

Table 8 Wind Speed = 30 m/sec

β	Side	H = 5.5 m					
		Altitude/distance category (AD)					
		AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R5	R6	R6	R7	R8	R8
	L	R3	R3	R3	R4	R4	R4
1.5	W	R10	R11	R11	x	x	x
	L	R2	R2	R2	x	x	x
2.0	W	x	x	x	x	x	x
	L	x	x	x	x	x	x
2.5	W	x	x	x	x	x	x
	L	x	x	x	x	x	x

Racking resistance for flat roofs

		Table 9 Wind Speed = 23 m/sec						**Table 10 Wind Speed = 25 m/sec**					
β	**Side**	**H = 5.5 m**						**H = 5.5 m**					
		Altitude/distance category (AD)						**Altitude/distance category (AD)**					
		AD1	AD2	AD3	AD4	AD5	AD6	AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R3	R3	R3	R4	R4	R5	R3	R3	R3	R4	R4	R5
	L	R3	R3	R3	R4	R4	R5	R3	R3	R3	R4	R4	R5
1.5	W	R6	R6	R7	R7	R8	R9	R6	R6	R7	R7	R8	R9
	L	R2	R2	R2	R3	R3	R3	R2	R2	R2	R3	R3	R3
2.0	W	R8	R9	R9	R10	R11	R11	R8	R9	R9	R10	R11	R11
	L	R1	R1	R2	R2	R2	R2	R1	R1	R2	R2	R2	R2
2.5	W	R9	R10	R11	R11	x	x	R9	R10	R11	R11	x	x
	L	R1	R1	R1	R1	x	x	R1	R1	R1	R1	x	x
3.0	W	R11	R11	x	x	x	x	R11	R11	x	x	x	x
	L	R1	R1	x	x	x	x	R1	R1	x	x	x	x
3.5	W	R11	x	x	x	x	x	R11	x	x	x	x	x
	L	R1	x	x	x	x	x	R1	x	x	x	x	x

		Table 11 Wind Speed = 27 m/sec						**Table 12 Wind Speed = 30 m/sec**					
β	**Side**	**H = 5.5 m**						**H = 5.5 m**					
		Altitude/distance category (AD)						**Altitude/distance category (AD)**					
		AD1	AD2	AD3	AD4	AD5	AD6	AD1	AD2	AD3	AD4	AD5	AD6
1.0	W	R4	R4	R4	R5	R5	R5	R4	R5	R5	R6	R6	R7
	L	R4	R4	R4	R5	R5	R5	R4	R5	R5	R6	R6	R7
1.5	W	R7	R7	R8	R9	R9	R10	R9	R9	R10	R11	R11	x
	L	R2	R3	R3	R3	R4	R4	R3	R3	R4	R4	R4	x
2.0	W	R9	R10	R11	R11	x	x	R11	R11	x	x	x	x
	L	R2	R2	R2	R2	x	x	R2	R2	x	x	x	x
2.5	W	R11	R11	x	x	x	x	x	x	x	x	x	x
	L	R1	R1	x	x	x	x	x	x	x	x	x	x

1.E.16 Masonry cladding arrangement

The extent to which masonry cladding contributes to the racking resistance of a timber frame wall depends on whether or not there are masonry buttressing walls providing lateral support to the wall cladding and the spacing of the buttressing.

Type 1 walls which are buttressed at both ends provide the best contribution through to type 3 walls with no returns the least. The type of masonry wall should be selected from the table below.

Type 1	Type 2	Type 3
Masonry walls with buttressing walls at least 550 mm in length and not more than 9 m centres .	Masonry walls with buttressing walls at one end at least 550 mm in length with the other end without buttressing walls not more than 550 mm length and wall length not more than 4.5 m.	Masonry walls without buttressing walls or with buttressing walls not more than 550 mm length.
		

1.E.17 Percentage openings in racking

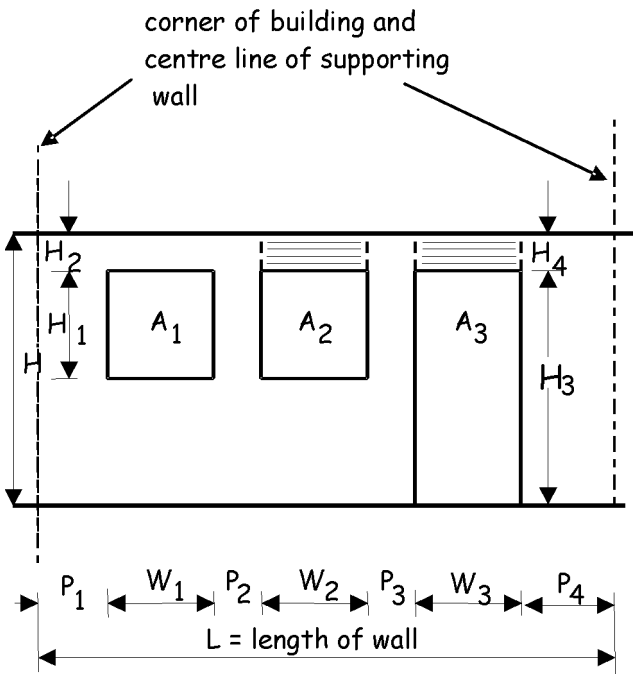
The actual percentage wall openings, $\%O_p$, for each wall should be assessed as set out below.

External racking wall area of the ground floor for each wall, A_{EX} = W x H and L x H

Total opening area, A_O, of the ground floor for a wall = (sum of lengths x widths of all openings)
$A_O = (W_1 \times H_1) + (W_2 \times H_2) + (W_3 \times H_3) + \ldots$

The total area of openings in a wall which acts as a racking wall should be assessed as a percentage of the total area of that wall :

Actual percentage wall opening,
$\%O_p = 100 \times A_O / A_{EX}$



Subject to the following:

where 2 framed openings are separated by not more than 300 mm and the heights of both openings are more than half the panel height, the area of opening should be taken as the rectangle that encloses both openings,
i.e. if $P_2 < 300$ mm then $(A_1 + A_2) = (W_1 + P_2 + W_2) \times H_1$

where there are limited areas of alternative cladding panels such as timber cladding above doors or windows (not exceeding 0.5 m^2) these areas should be added to the areas of openings,
i.e. $A_2 = W_2 \times (H_1 + H_2)$ and $A_3 = W_3 \times (H_3 + H_4)$

where an opening is not more than 300 mm from the corner of a *building* and the depth of opening is more than half the panel height and then the length of that part of the wall should be disregarded when determining the total length of wall,
i.e. if $P_1 < 300$ mm and $H_1 > H/2$, then $L = (L - P_1)$

1.E.18 Panel sheathing and nailing

The wall sheathing in combination with the nailing of the sheathing to the wall studs provides the racking resistance in the plane of that wall as shown in the diagram in clause 1.E.15 and combinations of sheathing and nailing can be read from the charts below using the following information:

- racking resistance, R , from clause 1.E.15;
- percentage openings, $\%O_p$, from clause 1.E.17;
- masonry wall type from clause 1.E.16.

a. select the appropriate chart below based on the wall type and number of *storeys*:
   - chart 1 provides wall sheathing for wall type 1 for 1 and 2 *storey buildings;*
   - chart 2 provides wall sheathing for wall type 2 for 1 and 2 *storey buildings;*
   - chart 3 provides wall sheathing for wall type 3 for 1 and 2 s*torey buildings*;

b. read the walling detail options for each wall for racking resistance and percentage wall openings:
   - single sheathed with 100 mm nail centres;
   - single sheathed with 150 mm nail centres;

c. select the walling detail;

d. if the percentage openings and racking bands are outwith the charts;
   - reconsider the parameters particularly the percentage wall openings; or
   - consider introducing an internal racking wall (refer to clause 1.E.19); or
   - obtain specialist advice from chartered engineers with the appropriate skills and experience.

Chart 1 Wall Type 1 at 1 and 2 storey

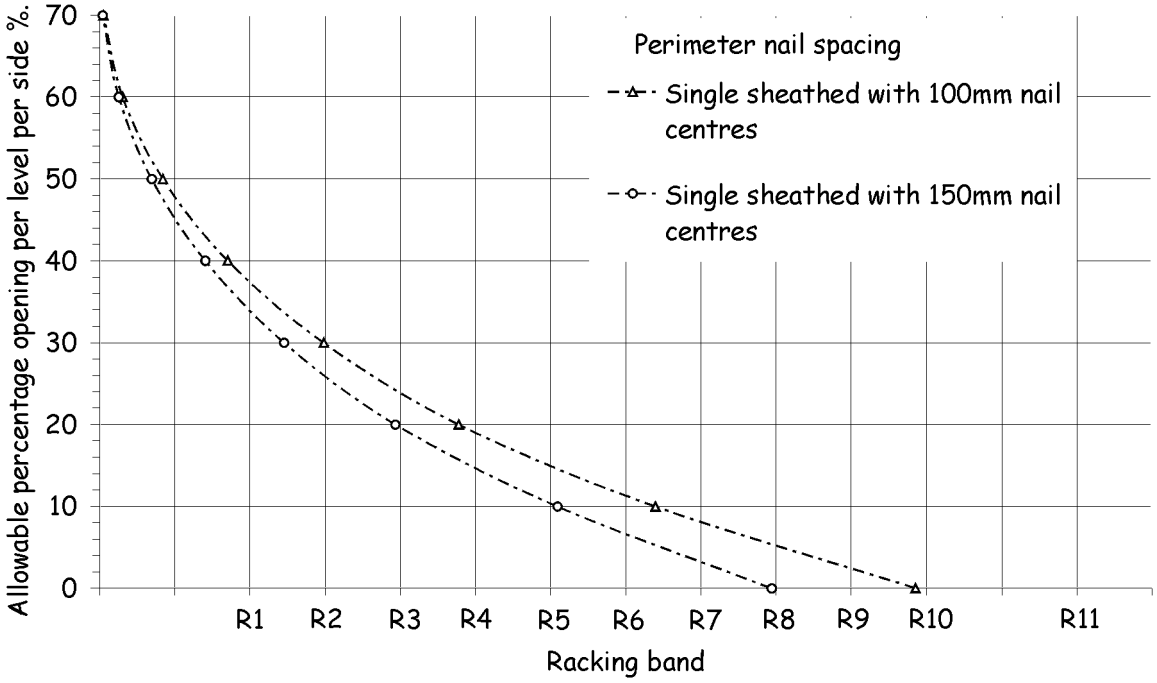


Chart 2 Wall Type 2 at 1 and 2 storey

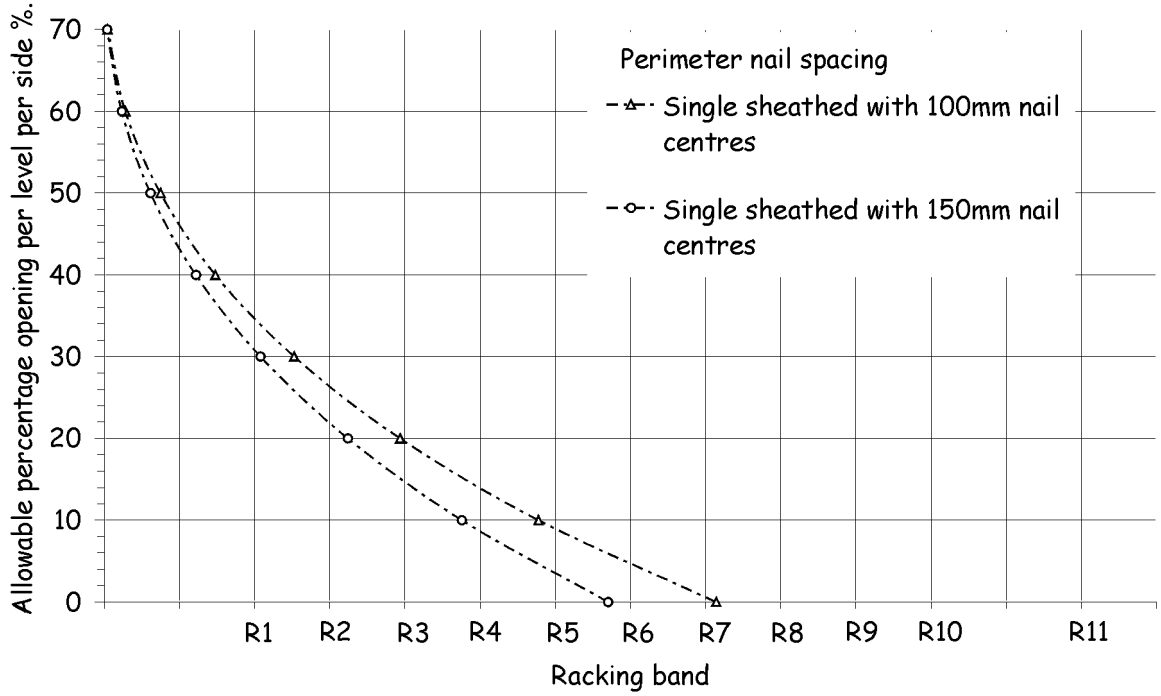
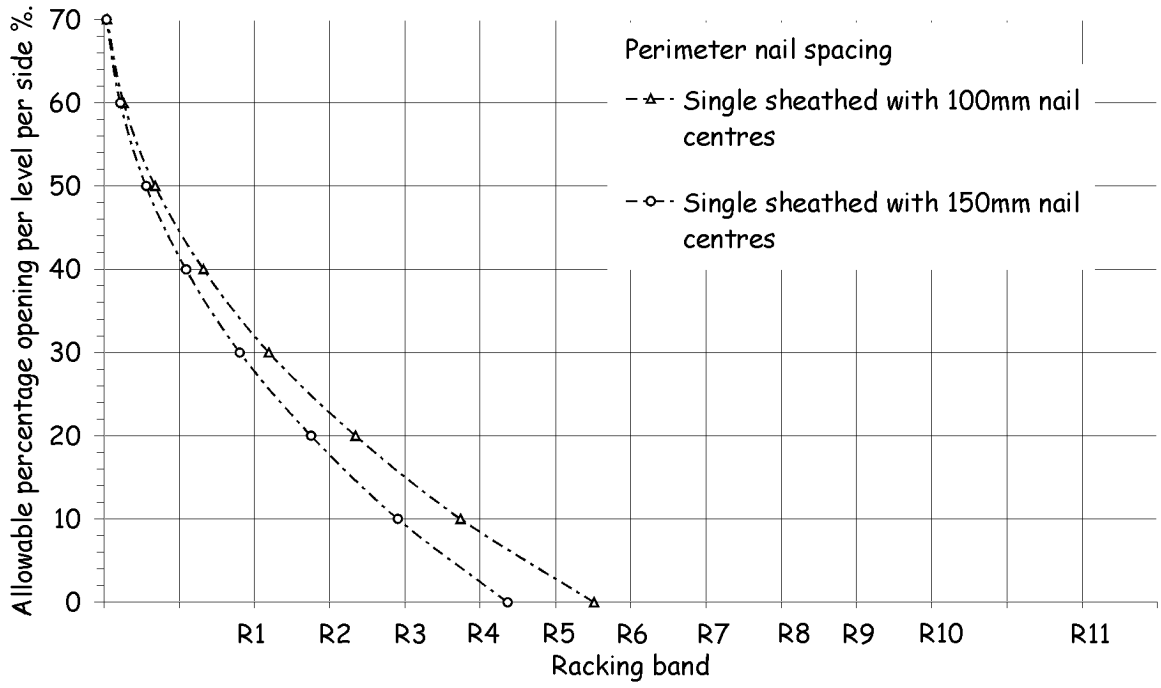


Chart 3 Wall Type 3 at 1 and 2 storey



1.E.19 Use of internal walls for additional racking resistance

Internal walls can be used to provide additional racking resistance provided the following apply to such walls:

a. support is provided by *foundations* at ground floor;
b. fixity to the *foundations* , floor or roof diaphragms is in accordance with clauses 1.E.39-40;
c. internal racking walls are sheathed as in clause 1.E.10;
d. only segments of wall at least 600 mm in length are used;
e. if the sum of the length of the racking walls varies between *storeys* , the length should be smallest sum.

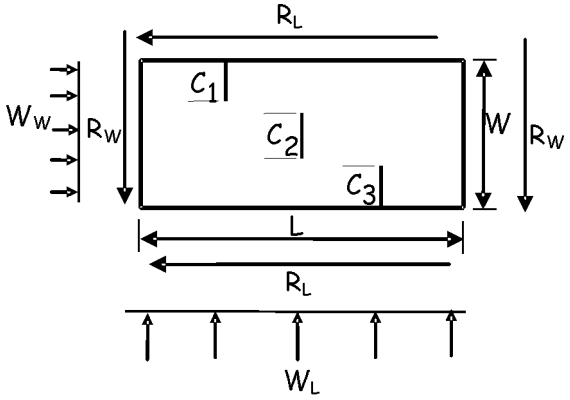
Key

W is the smaller dimension of the *building* plan

L is the larger dimension of the *building* plan

C is the sum of the lengths of the internal racking resisting walls ($C = C_1 + C_2 + C_3 + \ldots.$)

Plan where there are internal racking walls



Determine the revised length/ width ratio of the building plan area, $\beta = L /(W+(0.5\times C))$

Note that β should always be rounded up from the derived value to the nearest 0.5 and will be not less than 1.0 in any case.

Internal racking walls parallel to the length, L, of the *building* should be ignored in the calculation of β. However they can be used to enhance racking resistance in that direction to allow for an increased percentage of openings as follows:

a. the internal racking wall area, A_{IN} , should be split equally between each of the external racking wall areas, A_{EX} , which are parallel to that internal wall, allowing the percentage of openings calculated from clause 1.E.17 to be increased using the following equations:
   - revised area of opening, $A_{OP} = (A_{EX} + (A_{IN} / 2)) \times \%O_p$
   - revised percentage of openings per *storey* , $\%O_p = (A_{OP} /A_{EX}) \times 100$
b. read the walling detail options for each wall for racking resistance and revised percentage wall openings from the charts to clause 1.E.18;
c. select the walling detail;
d. if the percentage openings and racking bands are outwith the charts:
   - reconsider the parameters particularly the percentage wall openings; or
   - review internal racking wall arrangements; or
   - obtain specialist advice from chartered engineers or other appropriately qualified persons.

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1.E.20 Wind loads

The *wind loads* should be derived from the wind speed map and read from the table below using the information derived from above.

- overall *building* height, H from clause 1.E.11;
- distance to the coast, site altitude and wind speed from clause 1.E. 13.

Table of wind loads

Building height (m)	Wind speed (m/s)	Site altitude, a (m)							
		0		a ≤ 50		50< a ≤ 100		100< a ≤ 150	
		Distance to the coast (km)							
		≤ 10	≤ 100	≤ 10	≤ 100	≤ 10	≤ 100	≤ 10	≤ 100
≤ 5.5	23	H1	H1	H1	H1	H1	H1	H1	H1
	25	H1	H1	H1	H1	H1	H1	H1	H1
	27	H1	H1	H1	H1	H2	H1	H2	H2
	30	H2	H1	H2	H2	H2	H2	H3	H2
≤ 10	23	H1	H1	H1	H1	H1	H1	H1	H1
	25	H1	H1	H1	H1	H2	H1	H2	H2
	27	H2	H1	H2	H1	H2	H2	H2	H2
	30	H2	H2	H3	H2	H3	H3	H4	H3

Building height (m)	Wind speed (m/s)	Site altitude, a (m)					
		150< a ≤ 200		200< a ≤ 300		300< a ≤ 400	
		Distance to the coast (km)					
		≤ 10	≤ 100	≤ 10	≤ 100	≤ 10	≤ 100
≤ 5.5	23	H1	H1	H2	H2	H2	H2
	25	H2	H2	H2	H2	H3	H3
	27	H2	H2	H3	H3	H4	H3
	30	H3	H3	H4	H4	H5	H4
≤ 10	23	H2	H2	H2	H2	H3	H3
	25	H3	H3	H3	H3	H3	H3
	27	H3	H3	H4	H3	H5	H4
	30	H4	H4	H5	H5	H6	H6

1.E.21 Vertical loads

The vertical loads should be derived from the snow zone map in clause 1.E.13 using the following information derived from above:

- roof and floor spans and the number of *storeys* from clause 1.E.11;
- snow zone and site altitude from clause 1.E.13.

a. the *imposed loads* (snow) in kN/m ^{2} is read from the table below:

Imposed roof loads (kN/m^2)

Zone	Altitude below 100 m	Altitude between 100m and 200 m	Altitude between 200m and 260 m	Altitude between 260 m and 400m
A	0.75	1.00	Refer to BS 6399-3: 1988	Refer to BS 6399-3: 1988
B	1.00	1.50	1.50	Refer to BS 6399-3: 1988

b. Read the vertical snow load category (V1-V18) from the table below:

Vertical loads at heads of panels

Maximum roof or floor span (m) [1]	Imposed loads (kN/m^2)								
	0.75			1.00			1.50		
	Roof [2]	Floor [3]	Roof + 1 Storey [4]	Roof [2]	Floor [3]	Roof + 1 Storey [4]	Roof [2]	Floor [3]	Roof + 1 Storey [4]
1.0	V1	V1	V3	V1	V1	V3	V2	V2	V3
2.0	V4	V4	V7	V4	V4	V7	V5	V5	V7
3.0	V6	V6	V10	V6	V6	V10	V7	V7	V11
4.0	V8	V8	V12	V8	V8	V12	V9	V9	V13
5.0	V10	V10	V13	V10	V10	V14	V11	V11	V14
6.0	V10	V10	V14	V11	V11	V15	V11	V11	V15
7.0	V11	V11	V16	V11	V11	V16	V12	V12	V17
7.5	V11	V11	V17	V13	V13	V17	V13	V13	V18

Notes:

1. Roof or Floor span is the clear span between supports for a roof or a floor;
2. *Imposed loads* for Roof are loads onto the wallhead of first floor wall of a 2 *storey building* from the roof or loads onto the wallhead of the ground floor wall of a 1 *storey building* from the roof;
3. *Imposed loads* for Floor are loads onto the wallhead of the ground floor wall of a 2 *storey building* from the first floor only where the roof does not span onto that wall;
4. *Imposed loads* for Roof + 1 *Storey* are the loads on to the wallhead of the ground floor of a 2 *storey building* from the roof and the first floor wall where the roof and floor span in the same direction.

1.E.22 Wall stud sizing

The wall studs carry the vertical and *wind loads* imposed on the timber frame panels and the sizes of studs should be selected using the tables below using the information derived from above:

- *wind loads* (H1-5) from clause 1.E.20;
- vertical (snow) loads (V1-V18) from clause 1.E.21.

The wall stud sizes, centres and timber grade for the wall panels should be selected from the tables below. Note that strength class C16 timber is generally used for wall studs.

Minimum wall stud sizes for timber class grade C16

Table 1 Wind load category H1

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V11	38 x 89	400
V1 - V7		600
V1 - V18	38 x 114	400
V1 - V14		600
V1 - V18	38 x 140	400
V1 - V18		600

Table 2 Wind load category H2

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V11	38 x 89	400
V1 - V5		600
V1 - V18	38 x 114	400
V1 - V12		600
V1 - V18	38 x 140	400
V1 - V18		600

Table 3 Wind load category H3

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V9	38 x 89	400
V1 - V3		600
V1 - V17	38 x 114	400
V1 - V12		600
V1 - V18	38 x 140	400
V1 - V18		600

Table 4 Wind load category H4

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V8	38 x 89	400
V1 - V5		600
V1 - V16	38 x 114	400
V1 - V10		600
V1 - V18	38 x 140	400
V1 - V16		600

Table 5 Wind load category H5

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V7	38 x 89	400
none		600
V1 - V16	38 x 114	400
V1 - V9		600
V1 - V18	38 x 140	400
V1 - V15		600

Minimum wall stud sizes for timber class grade C24

Table 6 Wind load category H1

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V16	38 x 89	400
V1 - V10		600
V1 - V18	38 x 114	400
V1 - V17		600
V1 - V18	38 x 140	400
V1 - V18		600

Table 7 Wind load category H2

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V15	38 x 89	400
V1 - V9		600
V1 - V18	38 x 114	400
V1 - V16		600
V1 - V18	38 x 140	400
V1 - V18		600

Table 8 Wind load category H3

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V13	38 x 89	400
V1 - V7		600
V1 - V18	38 x 114	400
V1 - V14		600
V1 - V18	38 x 140	400
V1 - V18		600

Table 9 Wind load category H4

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V12	38 x 89	400
V1 - V6		600
V1 - V18	38 x 114	400
V1 - V13		600
V1 - V18	38 x 140	400
V1 - V18		600

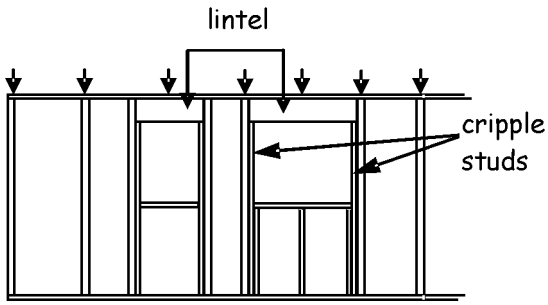
Table 10 Wind load category H5

Vertical load category	Timber size (mm x mm)	Centres (mm)
V1 - V12	38 x 89	400
V1 - V5		600
V1 - V18	38 x 114	400
V1 - V12		600
V1 - V18	38 x 140	400
V1 - V18		600

Wall studs to internal racking walls should be at least 38 x 89 size, grade C16 at 600 mm centres.

1.E.23 Cripple stud sizing

Cripple studs are connected to studs either side of an opening within a panel to provide support to a lintel above the openings as shown opposite. The sizes and numbers of cripple studs should be selected using the table below and using information derived from above:



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- lintel span from clause 1.E.11;
- vertical load (V1-V18) from clause 1.E.21;

Select the cripple stud sizes, numbers of sections and timber grade for the lintel spans from the tables below;

a. the number of cripple studs from the table is the number of studs in addition to the wall studs on each side of the opening;
b. all cripple studs should be of the same strength class and size;
c. strength class C16 timber is generally used for cripple studs;
d. x indicates that more than 3 cripple studs are needed and specialist advice should be obtained.

Minimum cripple stud sizes and numbers

Table 1 Timber of strength class grade C16

Vertical load	Lintel span (m)								
	1.240			1.800			2.475		
Stud size (mm x mm)	38x89	38x114	38x140	38x89	38x114	38x140	38x89	38x114	38x140
V1	1	1	1	1	1	1	1	1	1
V2	1	1	1	1	1	1	1	1	1
V3	1	1	1	1	1	1	1	1	1
V4	1	1	1	1	1	1	2	1	1
V5	1	1	1	1	1	1	2	1	1
V6	2	1	1	2	1	1	2	1	1
V7	2	1	1	2	1	1	2	1	1
V8	2	1	1	2	1	1	2	1	1
V9	2	1	1	2	1	1	2	1	1
V10	2	1	1	2	1	1	3	2	1
V11	2	1	1	3	2	1	3	2	1
V12	2	1	1	3	2	1	x	2	2
V13	2	1	1	3	2	1	x	2	2
V14	3	2	1	x	2	2	x	3	2
V15	3	2	1	x	2	2	x	3	2
V16	3	2	1	x	2	2	x	3	2
V17	3	2	1	x	3	2	x	3	2
V18	3	2	1	x	3	2	x	3	2

Table 2 Timber of strength class grade C24

Vertical load	Lintel span (m)								
	1.240			1.800			2.475		
Stud size (mm x mm)	38x89	38x114	38x140	38x89	38x114	38x140	38x89	38x114	38x140
V1	1	1	1	1	1	1	1	1	1
V2	1	1	1	1	1	1	1	1	1
V3	1	1	1	1	1	1	1	1	1
V4	1	1	1	1	1	1	2	1	1
V5	1	1	1	1	1	1	2	1	1
V6	1	1	1	2	1	1	2	1	1
V7	2	1	1	2	1	1	2	1	1
V8	2	1	1	2	1	1	2	1	1
V9	2	1	1	2	1	1	2	1	1
V10	2	1	1	2	1	1	3	1	1
V11	2	1	1	3	1	1	3	2	1
V12	2	1	1	3	2	1	x	2	2
V13	2	1	1	3	2	1	x	2	2
V14	3	2	1	3	2	2	x	3	2
V15	3	2	1	3	2	2	x	3	2
V16	3	2	1	3	2	2	x	3	2
V17	3	2	1	x	3	2	x	3	2
V18	3	2	1	x	3	2	x	3	2

1.E.24 Lintel sizing

Lintels provide support to openings and are supported by cripple studs at either end as shown on the diagram to clause 1.E.23. The sizes and numbers of sections for lintels should be selected using the table below using the information derived from above.

- lintel span from clause 1.E.11;
- vertical load (V1-V18) from clause 1.E.21.

Select the lintel sizes, numbers of sections and timber grade from the tables below:

a. the lintel span is the clear distance between support points of the cripple studs;
b. timber of strength class C24 is generally used for lintels;
c. all lintels should be of the same strength class and size;
d. 2 x 38 x 190 means 2 lintels 38 mm wide by 190 mm deep are required to satisfy the loading condition;
e. x indicates that more than 3 sections are needed to make up a lintel, or steel inserts (e.g. flitch beams) and specialist advice should be obtained.

Minimum lintel sizes and numbers of sections

Table 1 Timber of strength class grade C16

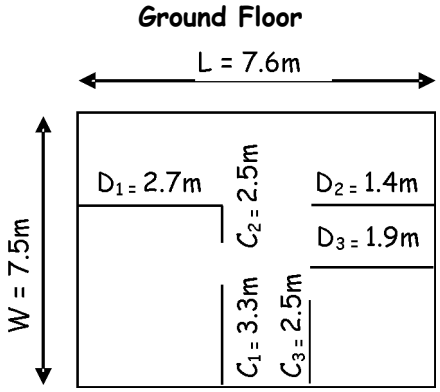
Vertical load	**Lintel span (m)**												
	1.240					**1.800**					**2.475**		
Stud size (mm x mm)	**38x 140**	**38x 190**	**44 x 190**	**44x 220**	**44x 240**	**38x 190**	**44x 140**	**44x 190**	**44x 220**	**44x 240**	**44x 190**	**44x 220**	**44x 240**
V1	2					2					x	2	
V2	2					2					x	x	2
V3	2					x	x	2			x	x	2
V4	2					x	x	2			x	x	2
V5	2					x	x	x	2		x	3	x
V6	2					x	x	x	2		x	3	x
V7	x	x	2			x	x	x	2		x	x	3
V8	x	x	2			x	x	x	2		x	x	3
V9	x	x	2			x	x	3	x		x	x	3
V10	x	x	2			x	x	3	x		x	x	x
V11	x	x	x	2		x	x	x	x	3	x	x	x
V12	x	x	x	2		x	x	x	x	3	x	x	x
V13	x	x	x	x	2	x	x	x	x	3	x	x	x
V14	x	x	x	x	3	x	x	x	x	x	x	x	x
V15	x	x	x	x	3	x	x	x	x	x	x	x	x
V16	x	x	x	x	3	x	x	x	x	x	x	x	x
V17	x	x	x	x	3	x	x	x	x	x	x	x	x
V18	x	x	x	x	x	x	x	x	x	x	x	x	x

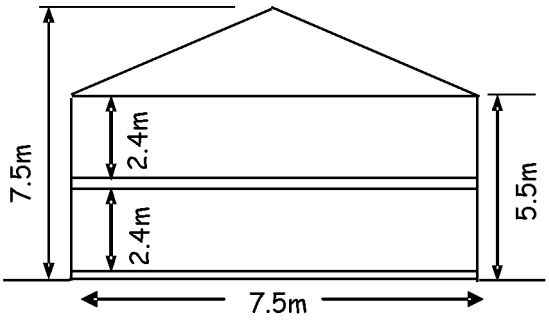
Table 2 Timber of strength class grade C24

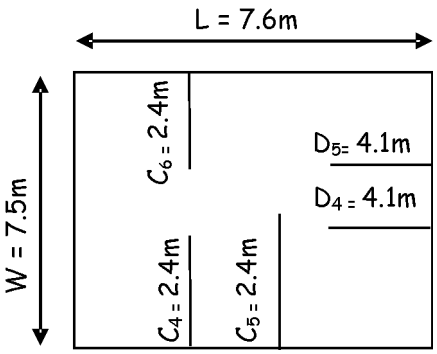
Vertical load	Lintel span (m)											
	1.240					1.800				2.475		
Stud size (mm x mm)	**38x 140**	**38x 190**	**44 x 190**	**44x 220**	**44x 240**	**44x 140**	**44x 190**	**44x 220**	**44x 240**	**44x 190**	**44x 220**	**44x 240**
V1	2					2				2		
V2	2					2				2		
V3	2					2				2		
V4	2					2				2		
V5	2					2				2		
V6	2					2				2		
V7	x	2				x	2			x	2	
V8	x	2				x	2			x	2	
V9	x	2				x	x	2		x	3	
V10	x	2				x	x	2		x	x	2
V11	x	x	2			x	x	x	2	x	x	3
V12	x	x	2			x	x	x	2	x	x	3
V13	x	x	x	2		x	x	x	2	x	x	x
V14	x	x	3	x		x	x	3	x	x	x	x
V15	x	x	3	x		x	x	x	3	x	x	x
V16	x	x	3	x		x	x	x	x	x	x	x
V17	x	x	x	3		x	x	x	x	x	x	x
V18	x	x	x	3		x	x	x	x	x	x	x

1.E.25 Example

Site Data		
Distance to coast	km	15
Altitude, a	m	150
Snow zone	A or B	A
Wind speed	m/s	23.5
Building Data		
Width, W	m	7.5
Length, L	m	7.6
Height to eaves	m	5.5
Storeys	No	2
Building height, H	m	7.5
Roof shape	duo/mono/flat	duo
Panel height, H	m	2.4







Racking

Wall type = 1

Number of *storeys* = 2

From table 1 to clause 1.E.14, altitude/distance category = AD3

For ground floor:

internal racking wall, resisting wind onto *building* width, C = $C_1 + C_2 + C_3 = 8.3$ m

internal racking wall, resisting wind onto *building* length, D = $D_1 + D_2 + D_3 = 6.0$ m

For first floor:

internal racking wall, resisting wind onto *building* width, C = $C_4 + C_5 + C_6 = 7.2$ m

internal racking wall, resisting wind onto *building* length, D = $D_4 + D_5 = 8.2$ m

Adopt lesser values giving : C = 7.2 m

D = 6.0 m

Length/width ratio $\beta = L/(W + 0.5 \times C) = 7.6/(7.5 + 3.6) = 0.68 < 1.0$. Therefore adopt $\beta = 1.0$

From table 1 for $\beta = 1.0$, AD3 category and wind speed of 23 m/sec,
Racking bands are : For side W = R4 and for side L = R5

From the above parameters the initial wall options are as shown in the table below
(before allowing for the effect of internal racking walls)

Side	Racking band	Wall options (From Chart 1 to clause 1.E.18)	Allowable % opening / level per side
W	R4	1. Single sheathed with 100 mm nail centres	19
		2. Single sheathed with 150 mm nail centres	14
L	R5	1. Single sheathed with 100 mm nail centres	15
		2. Single sheathed with 150 mm nail centres	10

In accordance with clause 1.E.19, % openings in the *external walls* may be increased:

Width walls:

Effective area of external racking wall, A_{EX} = 7.5 m × 2.4 m = 18 m^2

Effective area of internal racking walls, A_{IN} = 7.2 m × 2.4 m = 17.28 m^2

Area of allowable opening per level, $A_{OP} = (A_{EX} + (A_{IN} / 2)) \times \%O_p$

For example, consider side W, option 1: single sheathed with 100 mm nail centres:

$A_{OP} = (18 + (17.28/2)) \times 19\ \%$

$A_{OP} = 5.1\ m^2$

Therefore, $\%O_p = (5.1 / 18) \times 100 = 28\ \%$

Length walls: A_{EX} = 7.6 m x 2.4 m = 18.24 m^2

A_{IN} = 6.0 m x 2.4 m = 14.4 m^2

$A_{OP} = (A_{EX} + (A_{IN} / 2)) \times \%O_p$

For example consider side L, option 5: single sheathed with 100 mm nail centres:

$A_{OP} = (18.24\ m^2 + (14.4\ m^2 /2)) \times 15\ \%$

$A_{OP} = 3.82\ m^2$

Therefore, $\%O_p = (3.82 / 18.24) \times 100 = 21\ \%$

The table can therefore be revised as follows allowing for internal racking walls effect.

Side	Racking band	Wall options (From Chart 1 to clause 1.E.17)	Allowable % opening / level per side
W	R4	1. Single sheathed with 100 mm nail centres	28
		2. Single sheathed with 150 mm nail centres	21
L	R5	1. Single sheathed with 100 mm nail centres	21
		2. Single sheathed with 150 mm nail centres	14

Wall studs

From table to 1.E.20, *wind load* category is H1

From table 1.E.21, *imposed load* =1.00 kN/m^2 leading to vertical load category = V17

From table 1 to 1.E.22 select 38 x 140, grade C16 wall stud at 600 mm centres

Cripple studs

For load V17 and 1.2 m opening, table 1 to 1.E.23 gives 1 no. 38 x 140 cripple studs grade C16 each side of opening

Lintels

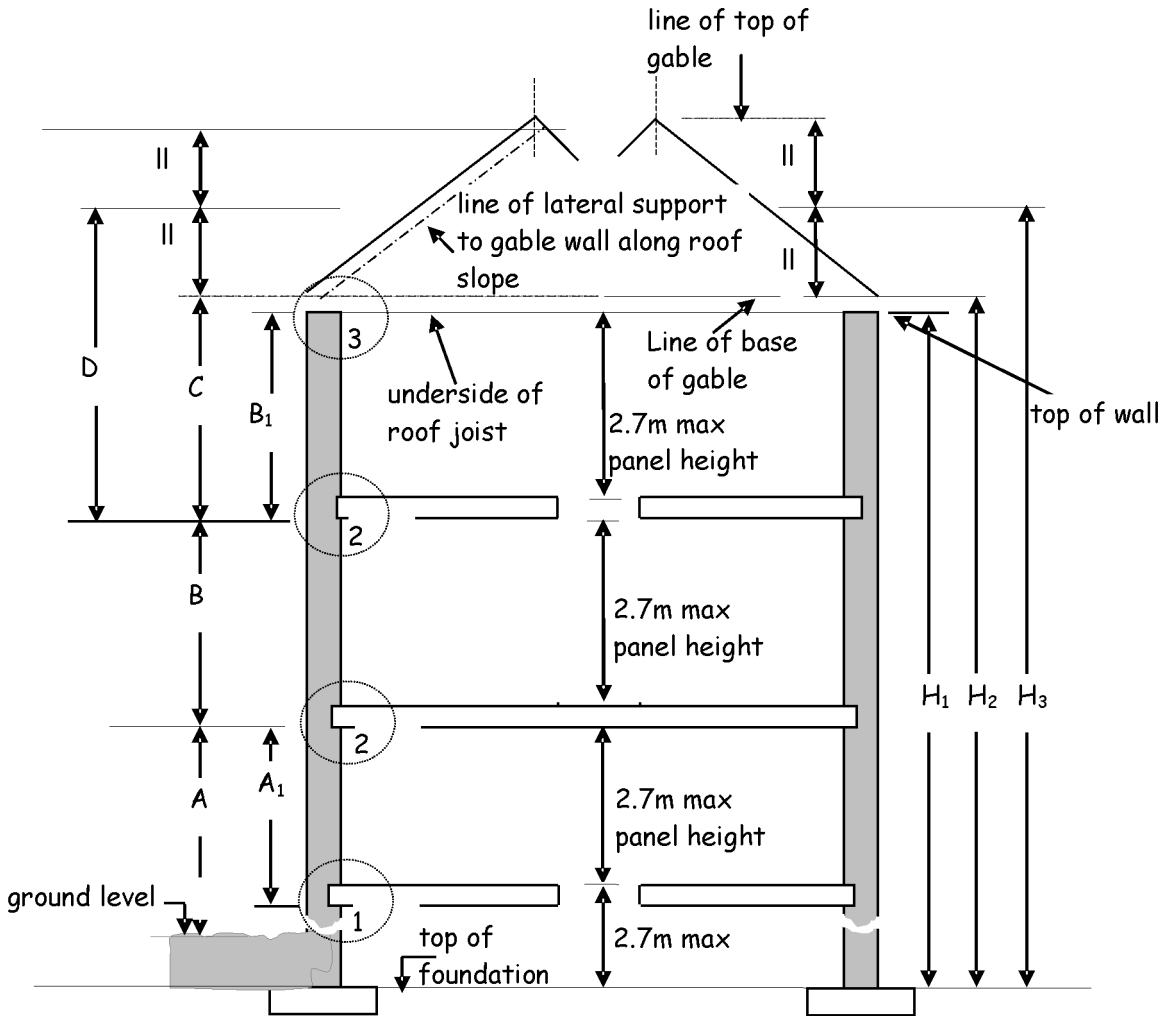
For load V17 and 1.2 m opening, table 2, to 1.E.24 gives 3 no 44 x 220, grade C24 lintels

1.E.26 Maximum allowable length of wall and building height

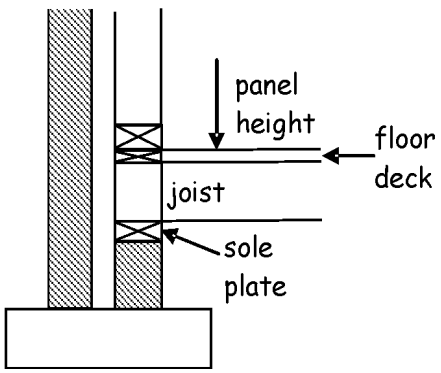
This annex does not deal with walls longer than 9 m, measured from centre to centre of buttressing walls, or of *buildings* with an overall height more than 10 m.

1.E.27 Rules of measurement for storeys, walls, panels and heights

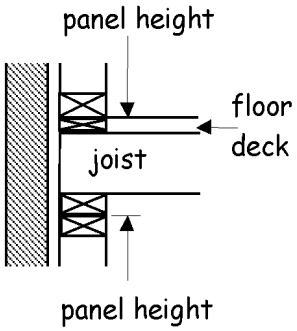
The height of a wall or a *storey* should be measured in accordance with the following diagram.



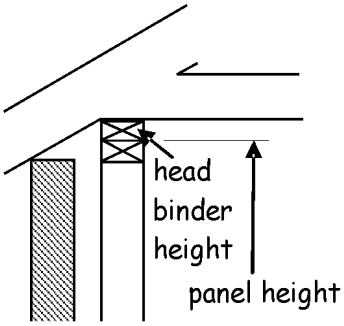
Detail 1



Detail 2



Detail 3



Key

(a) Measuring storey heights

A is the *ground storey* height if the ground floor is a suspended timber floor or a structurally separate ground floor slab

A_1 is the *ground storey* height if the ground floor is a suspended concrete floor bearing on the *external wall*

B is the intermediate *storey* height

B_1 is the top *storey* height for walls which do not include a gable

C is the top *storey* height where lateral support is given to the gable at both ceiling level and along the roof slope

D is the top *storey* height for walls which include a gable where lateral support is given to the gable only along the roof slope

(b) Measuring wall heights

H_1 is the height of a wall that does not include a gable

H_2 is the height of a *separating wall* which may extend to the under side of the roof

H_3 is the height for a wall (except a *separating wall*) which includes a gable

(c) Measuring timber panel heights

Panel heights are measured from the underside of the bottom rail to the top of the top rail

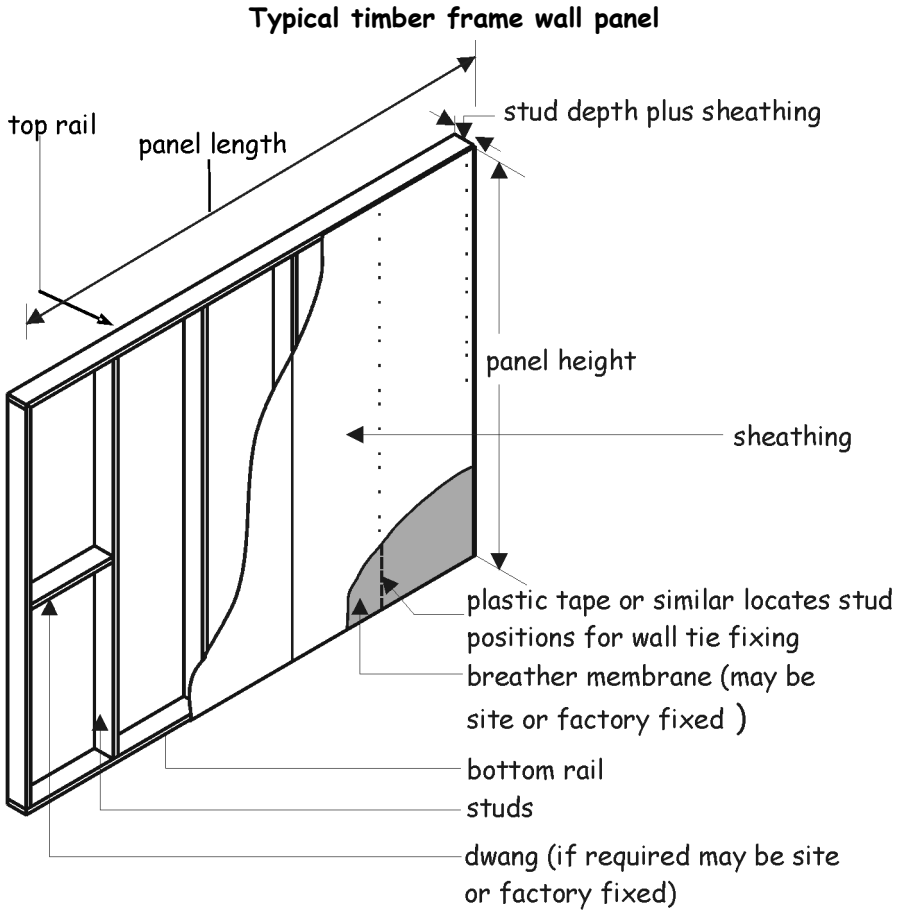
(d) Measuring building height

Building heights are measured from the lowest finished ground level to the highest point of the *roof*

Note that these methods of measurement are unique to SBSG and distinct from regulation 7.

1.E.28 Construction materials

The *construction* materials and methods are restricted to those materials, timber strength classes, specifications and dimensions which are most commonly used in Scotland for simple platform timber frame *buildings* as shown in the diagram below.



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1.E.29 Wall ties

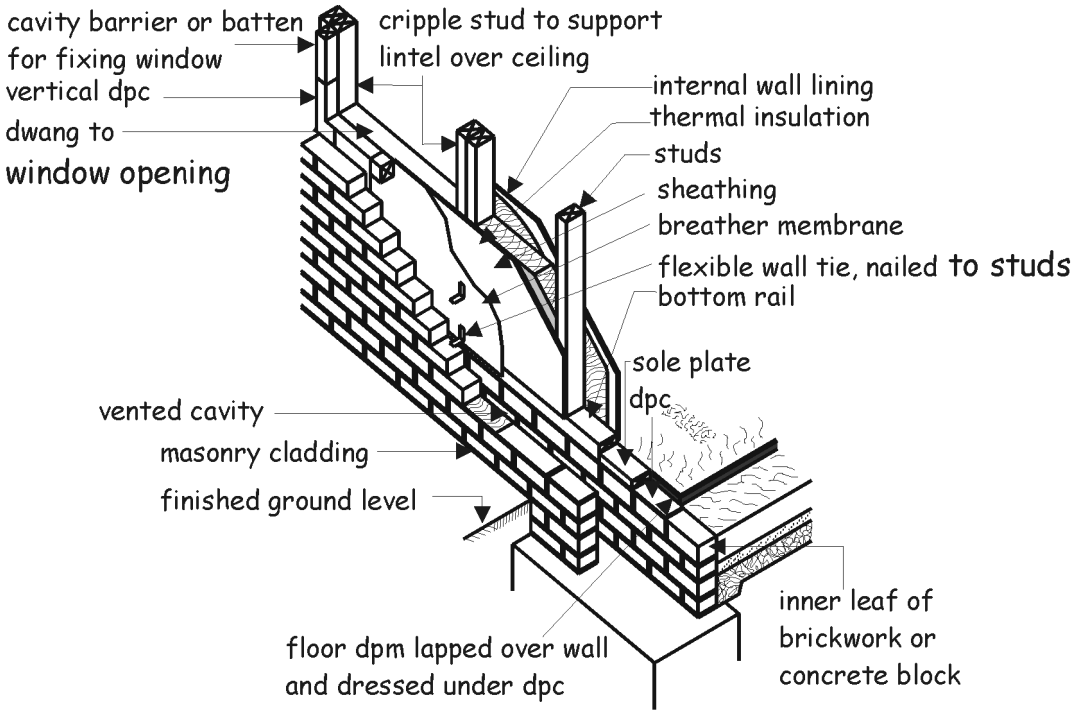
Wall ties should be in accordance with the guidance in BS EN 845-1: 2003 and be material references 1 or 3 in BS EN 845-1: 2003 Table A1 austenitic stainless steel.

The type of tie should be selected by reference to DD 140-2: 1987 type 5 (timber frame) or type 6 (timber frame high movement) to permit vertical downward movement of timber frame in relation to the masonry cladding of 6 mm/ *storey* height.

Reference should also be made to clause 1.D.17 for selection of wall ties regarding cavity width and embedment details.

1.E.30 Masonry Cladding

A typical masonry clad timber frame wall is illustrated below.



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1.E.31 Brick and block construction

Brick and block used as masonry cladding should be in accordance with annex 1.D and should be in accordance with the guidance in BS 5628-1: 2003, BS 5628-2: 2003 and BS 5628-3:2003, at least 100 mm thick with a minimum density of 7.36 kN/m^3.

1.E.32 Mortar

Mortar used in masonry cladding should be in accordance with annex 1.D.

1.E.33 Lintels for masonry cladding

Proprietary steel or concrete lintels used with masonry cladding to timber frame *construction* should be tested by a *notified body* or justified by calculations. Under no circumstances should any part of the masonry walls be supported by the timber frame.

1.E.34 Timber members

All structural timber members should be dry graded and marked with the timber species and grade combinations to satisfy strength classes C16 or C24 to BS 5268-2: 2002.

Normally strength class C16 is used for all members except lintels which are normally strength class C24. Care should be taken where different strength class timber has been used in the design that the correct classes are used for the members specified.

The cross sectional dimensions given in this annex are:

a. CLS or ALS sizes in accordance with BS EN 336: 2003, table NA.5 to tolerance class 2; or
b. equivalent timbers with dimensions in accordance with BS EN 336: 2003, table NA.4 to tolerance class 2 (but should not have lesser dimensions to those in a. above).

Although 38 mm widths are provided in the tables above for studs, cripple studs and lintels 44 mm width timbers are commonly used to provide an increased width to which plasterboard can be fixed.

Bottom and top rails, sole plates and head binders should be the same cross sectional dimensions and strength classes as the wall studs.

1.E.35 Wall sheathing

Plywood used as sheathing to timber frame should be 9.5 mm minimum thickness of species and grade as defined in BS 5268-2: 2002, Bonding Class 2 or 3 to BS EN 314-2: 1993.

Oriented Strand Board used as sheathing to timber frame should be at least 9.0 mm thick, Type 3 (OSB3): load bearing boards for use in humid conditions to BS EN 300: 2006.

Plasterboard used as wall linings should be 12.5 mm minimum thickness for stud centres not more than 600 mm to BS 8212: 1995.

1.E.36 Fasteners

All structural fasteners should be corrosion resistant and checked for compatibility with preservative, treatments used and any other metalwork with which they are in contact. Nails should be manufactured from mild or stainless steel and be of round head or “D” head configuration to the diameter and length stated.

Ground floor fasteners should be stainless steel or galvanised.

1.E.37 Fabrication

Timber members in wall panels should be at least 38 mm × 89 mm rectangular section with linings fixed to the narrower face, with ends cut square.

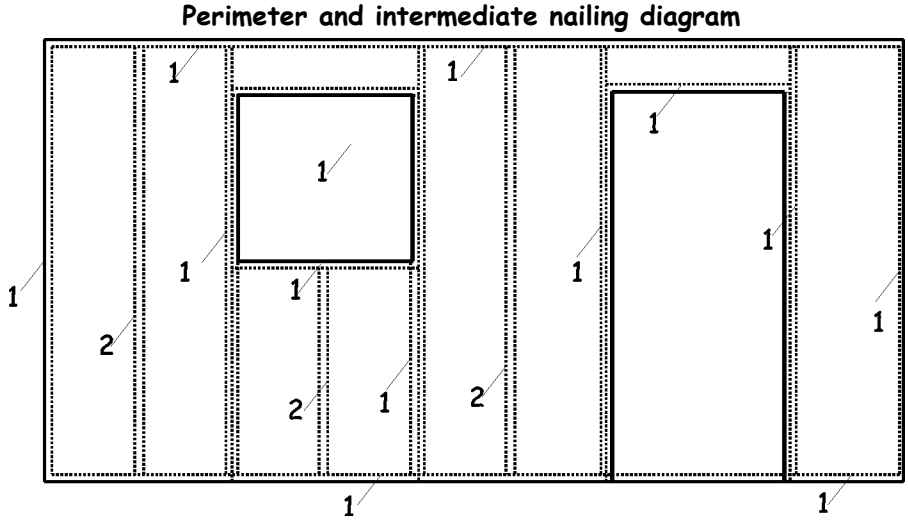
Wall studs should be spaced at not more than 600 mm centres and should be vertically aligned to coincide with the floor joists and roof trusses.

Masonry cladding should be *construct*ed on to the *building foundation* and tied back to the timber frame structure with a cavity width of 50 mm between the inside face of the masonry cladding and the outer face of the timber frame wall.

1.E.38 Composite action

Timber frame walls should be considered to act compositely if they are *constructed* in accordance with clauses 1.E.37 and 1.E.39, ensuring that sheathings and linings are nailed to all perimeter and intermediate timber members as on the diagram below and as follows:

a. sheathing edges should be backed by and nailed to timber framing at all edges; and
b. where sheathing is nailed to studs, the nails should be at least 7 mm from the edge of the board or the face of the stud; and
c. for plasterboard linings, nails should be at least 10 mm from formed board edges and at least 13 mm from ends of the board at centres not more than 150 mm; and
d. internal walls which are lined with plasterboard should be connected to the wall studs at the same perimeter nail centres as for external sheathing material; and
e. fixing of perimeter studs to sheathing,1, should be at the centres derived from clauses 1.E.10-19; and
f. fixing of intermediate studs to sheathing, 2, should be at not more than twice the centres of the perimeter nailing.



1.E.39 Wall panel connections

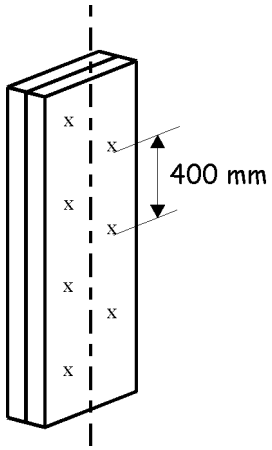
To ensure that wall panels are able to resist overturning forces they should be combined to form lengths of wall as follows:

a. tops and bottoms of individual wall panels should be linked by head binders and sole plates respectively that are continuous across panel joints including at junctions of the same dimensions as the top and bottom rails as in clause 1.E.40; and
b. sole plates should be secured to either the concrete floor slab or the header joists in the case of a timber ground floor or the header joists of the intermediate floor; and
c. header plates should be secured to the header joists of the intermediate floor or the roof trusses; and
d. faces of end studs of contiguous panels should be fixed such that any vertical shear is transferred as in clause 1.E.40; and
e. all edges including those to openings for windows, doors, etc. other than at the bases of door openings and small openings should be supported by timber members having a thickness not less than the thickness of the studs; and
f. where a secondary board is fixed on the same side of a wall as the primary sheathing then the nail lengths given in clause 1.E.40 should be increased to take account of the additional thickness; and
g. panels above and below openings should be fixed such that the horizontal forces are transferred in the plane of the panel above and below openings by 3.35 mm nails of length 75 mm at 300 mm centres.

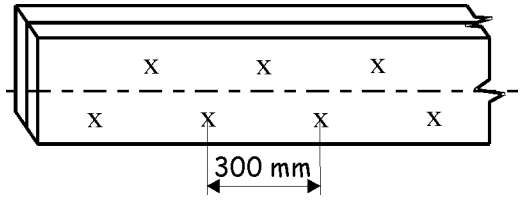
1.E.40 Nailing and fixing schedule

Item	Recommended fixing
Foundations	
Sole plate to under building	Mechanical fixings at 600 mm centres rated at 4.7 kN shear resistance
Holding down straps providing at least 3.5 kN of resistance.	Stainless steel strap 30 mm x 2.5 mm attached to stud by 6 no. 3.36 mm x 65 mm ring shank nails at 2.4 m centres, at every opening and at the end studs of a wall attaching the strap to the stud and placing the L-shaped end of the strap under the masonry cladding creating the holding down resistance
Wall panels	
Top rail of panels to head binders	Tops of individual wall panel members linked by member continuous across panel joints secured with 4.0 mm x 90 mm galvanised wire nails, 2 nails between stud centres
Sole plate to ring beam/ joist	4.0 mm x 90 mm galvanised wire nails, 2 nails between stud centres.
Bottom rail to sole plate	4.0 mm x 90 mm galvanised wire nails, 2 nails between stud centres.
Wall panel stud to wall panel stud	4.0 mm x 90 mm galvanised wire nails at 600 mm centres each side staggered.
Header plate to intermediate floor	4.0 mm x 90 mm galvanised wire nails at 300 mm centres. Nails skewed externally through rimboard into headbinder and internally skewed through the headbinder into the joists .
Sheathing to perimeter studs	3.1 mm x 50 mm wire nails at 100 or 150 mm centres as calculated
Intermediate studs to sheathing	3.1 mm x 50 mm wire nails at twice perimeter centres
Studs to plasterboard	2.65 mm x 40 mm smooth shanked galvanised flat round headed nails at 150 mm centres
Top and bottom rails to studs	2 no 4.0 mm x 90 mm nails end fixed
Spandrel panels to wall panel head	4.0 mm x 90 mm galvanised wire nails, 2 nails between stud centres.

Multi-cripple studs should be secured to each other with 3.1 mm × 64 mm galvanised ringshank nails at 400 mm centres, staggered mid distance between edge and centreline, with no nail closer than 60 mm to end of studs.

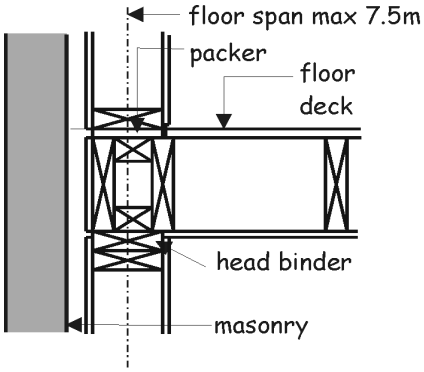


Lintels should be secured to each other with
3.1 mm × 75 mm galvanised screws or
3.1 mm × 75 mm galvanised ringshank nails at 300 mm centres, staggered mid distance between edge and centreline, with no screw closer than 60 mm to end of lintel.



1.E.41 Maximum span of floors

The maximum span for any floor supported by a wall should be 7.5 m, where the span is measured centre to centre of bearing as opposite. Where spans exceed 7.5 m intermediate load bearing walls can be used.



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1.E.42 Other loading conditions

a. vertical loading on walls from timber floors and flat roofs designed in accordance with annex 1.F, timber roof trusses;
b. combined *dead load* and *imposed load* should be not more than 70 kN/m at base of wall;
c. timber frame walls should commence above ground level and therefore are not subject to lateral loads other than from wind.

1.E.43 End restraint

The *wind load* is resisted primarily by transfer directly to the *foundations* at the base of the wall and by the racking resistance of the timber frame supporting walls, the load having been transferred via the floor and ceiling diaphragms.

The ends of every wall should be securely tied throughout their full height to the walls which are providing the racking resistance.

The *external wall*s which are perpendicular to the walls which are subject to the *wind load* provide lateral support and should be designed as racking walls.

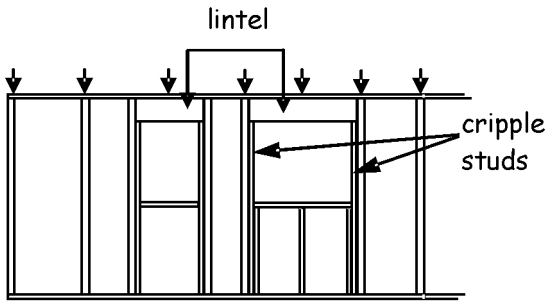
Internal walls can be used to provide additional racking resistance as in clause 1.E.19.

1.E.44 Openings, notching and drilling

The number, size and position of openings should not impair the stability of a wall or the lateral support afforded to a supported wall. *Construction* over openings should be supported.

1.E.45 Framing of openings

Loads over openings in timber frame wall panels are carried independently by timber lintels which should be supported by cripple studs as shown below.



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1.E.46 Dimensional criteria for openings

The dimensional criteria are given in the diagram to clause 1.E.17.

Openings in walls below ground floor should be limited to small holes for services and ventilation etc. not more than 0.1 m^2 and at least 2 m apart.

1.E.47 Small unframed openings

The size and position of small openings above ground floor level should be restricted as follows:

a. not more than 250 mm in diameter or in length of side; and
b. the clear distance between openings should be at least the greatest dimension of the openings; and
c. the clear distance between the edge of sheathing and the edge of any opening should be at least the greatest dimension of the opening; and
d. not more than one such opening should occur in any one 600 mm width of sheathing or lining.

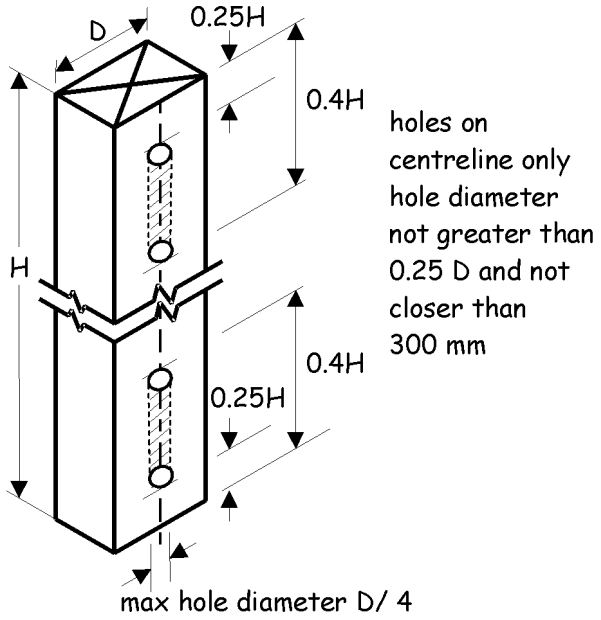
Smaller unframed openings may occur to a greater extent, but their aggregate opening area should be not more than the total area of opening given in item a. and the position of these openings should be as above.

1.E.48 Notching & drilling

Holes should be within the limits set out opposite and as follows:

- holes should be drilled at the neutral axis;
- holes should be at least 300 mm apart.

There should not be any notching of wall studs, cripple studs or lintels.



1.E.49 Lateral support by roofs and floors

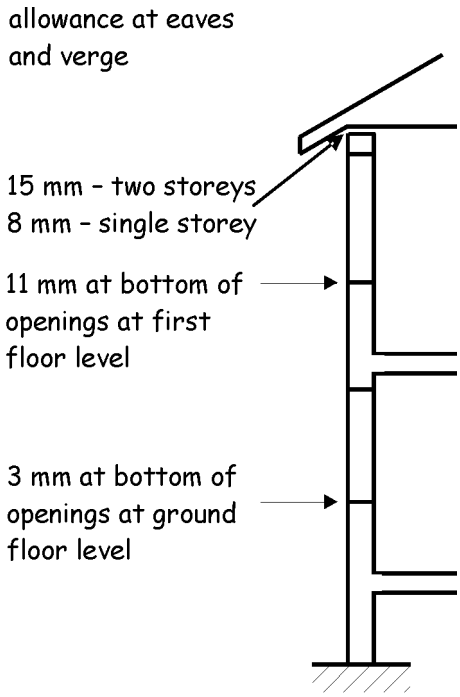
The wall panels in each *storey* of a *building* should extend to the full height of that *storey*, and be connected to the floors and roofs to provide diaphragm action and transfer lateral forces from the walls to the racking walls and:

a. the floor deck of intermediate floors should be fixed directly to the top faces of the joists; and
b. for pitched roofs, the plasterboard ceiling of the top *storey* should be fixed directly under the roof, together with the roof bracing as recommended in clause 1.B.2; and
c. be secured to the supported wall by connections recommended in clause 1.E.40;
d. spandrel panels should be tied into roof bracing with dwangs placed between vertical elements of the spandrel at a level to accommodate the bracing elements fixed by at least 3.1 mm x 75 mm screws (refer to clause 1.B.2).

1.E.50 Differential movement

Allowance should be made for differential movement between timber and masonry *construction* particularly vertical movement between timber frame walls and masonry cladding or stair enclosures. The allowances shown below are based upon:

a. conventional platform frame *construction*; and
b. concrete ground floor; and
c. intermediate floor joists not more than 200 mm depth; and
d. installed timber moisture content of 20% drying to 10%.



If timber ground floors are used, 8 mm should be added to all of the allowances shown above.

For a timber frame extension which is connected to an existing traditional masonry wall, the roof to the extension should be supported on a timber bearer connected to the existing wall to minimise the differential movement between the existing and new *construction*.

Annex

1.F Timber floors and roof members

contents

1.F.0 Introduction

This annex applies only to *domestic buildings* but restricted to *houses* of not more than 3 *storeys*.

1.F.1 Explanation of terms

The following terms are used in annex 1.F in addition to the definitions and explanation of terms in Appendix A of the Technical Handbooks

Trimming joist means a joist which for part or all of its length forms the edge of an opening (such as a stair well) and supports the end of a trimmer joist.

Trimmer joist means a joist supported at one or both ends by a trimming joist and supporting the ends of trimmed joists.

1.F.2 The use of this annex

This annex should be used in conjunction with annex 1.B. The guidance given in this annex assumes that:

a. the *dead loads* and *imposed loads* to be supported by the floor, ceiling or roof of which the member forms part, are not more than the values given in the notes to the diagrams and tables; and
b. the species and grade of timber for the strength class to which the table to clause 1.F.3 relates is either as in clause 1.F.3 for more common species, or as in the more comprehensive tables of BS 5268-2: 2002; and
c. that floorboarding is in accordance with BS 1297: 1987 or moisture resistant wood chipboard type P5 in accordance with BS EN 312: 2003; and
d. the strength classes, species, grades and species combinations are as defined in BS 5268-2: 2002; and
e. the cross sectional dimensions are:
   - CLS or ALS sizes in accordance with BS EN 336: 2003, Table NA.5, tolerance class 2;
   - equivalent timbers to dimensions in accordance with BS EN 336: 2003, Table NA.4, tolerance class 2 but at least the dimensions above

The tables do not apply where these dimensions have been reduced in the case of the tables to clause 1.F.9 by planing and in the case of the tables to clause 1.F.10 by planing or regularising. For timber of North American origin the tables only apply as indicated to surfaced sizes unless the timber has been resawn to BS EN 336: 2003.

Bearing areas and workmanship should be in accordance with BS 5268-2: 2002. Refer also to clauses 1.D.35-37 or clause 1.E.49 respectively for masonry and timber frame walls.

Where trussed rafters are used, reference should be made to BS 5268-3: 2006 for design and bracing recommendations subject to the following:

a. joints should be by means of punched metal plates with integral teeth; and
b. rafter types should be restricted to prefabricated duo or mono pitch fink trussed rafters; and
c. roof plan shape should be either square or rectangular; and
d. the *roof space* is not for living accommodation; and
e. roof members which impose point loads onto walls (e.g. hip and girder trusses) should not be used without specialist advice from chartered engineers or appropriately qualified persons; and
f. members of trussed rafters should not be cut, trimmed, notched or otherwise altered.

1.F.3 Common species/grade combinations satisfying the strength classes

			Grades to satisfy strength	
Species	**Origin**	**Grade rule**	**C16**	**C24**
All species listed in this table		BS EN 519: 1995	machine graded to C16	machine graded to C24
Imported Redwood or Whitewood		BS 4978: 1996	GS	SS
Douglas Fir, Larch, British Pine,British Spruce	UK	BS 4978: 1996	SS	x
Douglas Fir-Larch,	Canada	BS 4978: 1996	GS	SS
Hem-Fir,Spruce-Pine -Fir,			GS	SS
Sitka spruce			SS	x
Douglas Fir-Larch Hem-Fir Spruce-Pine-Fir	Canada	NLGA[2]	Joist & plank No 1 & 2 Structural L.F. No 1 & 2	Joist & plank select Structural L.F. select
Sitka spruce			Joist & plank select Structural L.F.	x
Douglas Fir-Larch, Hem-Fir, Spruce-Pine-Fir	Canada	MSR[2]	1450f-1.3E	1800f-1.6E
			1450f-1.3E	1800f-1.6E
Douglas Fir-Larch Hem-Fir,Southern Pine,Spruce-Pine-Fir Western Whitewoods	USA	BS 4978: 1996	GS	SS
			GS	SS
			GS	SS
			SS	x
Douglas Fir-Larch, Hem-Fir	USA	NGRDL[2]	Joist & plank No 1 & 2 Structural L.F. No 1 & 2	Joist & plank select Structural L.F. select
Spruce-Pine-Fir			Joist & plank No 1 & 2 Structural L.F. No 1 & 2	Joist & plank select Structural L.F. select
Western Whitewoods			Joist & plank select Structural L.F.	x
Southern Pine			Joist & plank No 3 Stud grade	Joist & plank select
Douglas Fir-Larch, Hem-Fir, Southern Pine, Spruce-Pine-Fir	USA	MSR[2]	1450f-1.3E	1800f-1.6E

Notes:

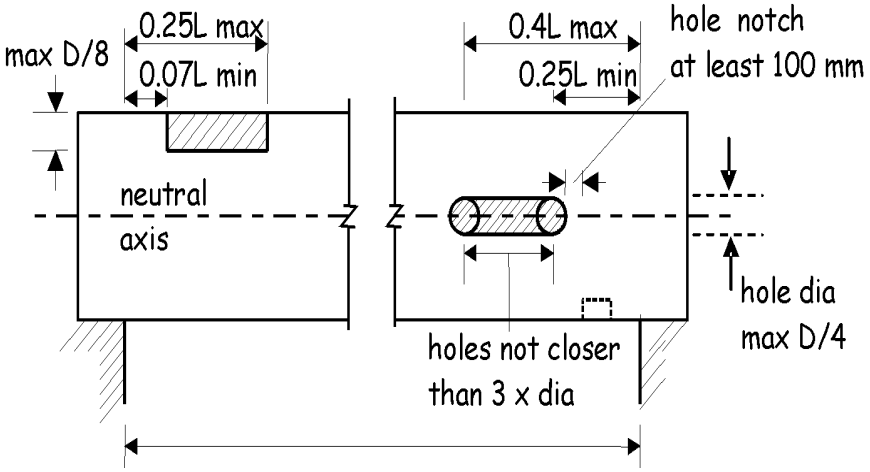
1. The species/grade combinations given in this table are for particular use with the other tables in this annex and for the cross section sizes given in those tables.
2. The grading rules for American and Canadian Lumber are those approved by the American Lumber Standards Board of Review and the Canadian Lumber Standards Accreditation Board respectively.
3. Comprehensive tables for species/grade combinations for strength classes are given in BS 5268-2: 2002

1.F.4 Notches and holes

Floor and flat roof joists

Notches and holes in simply supported floor and *flat roof* joists should be within the following limits:

a. holes should only be drilled at the neutral axis; and
b. notches and holes should be at least 100 mm apart horizontally; and
c. notches may be at the top or bottom of a joist but not coinciding.



Raised tie and collared roof members

Notches and holes should not be cut in rafters, ties, collars or hangers.

Trussed rafter members

Members of trussed rafters should not be cut, trimmed, notched or otherwise altered.

1.F.5 Strutting to joists

Floor joists spanning more than 2.5 m should be strutted by one or more rows of solid timber strutting as listed in the following table. Solid timber strutting should be at least 38 mm thick extending at least 3/4 depth of joist.

Joist span (m)	Number of rows of strutting	Position
Less than 2.5	none	N/A
2.5 to 4.5	1	at mid span
more than 4.5	2	at 1/3 span

1.F.6 Dead floor and roof loads

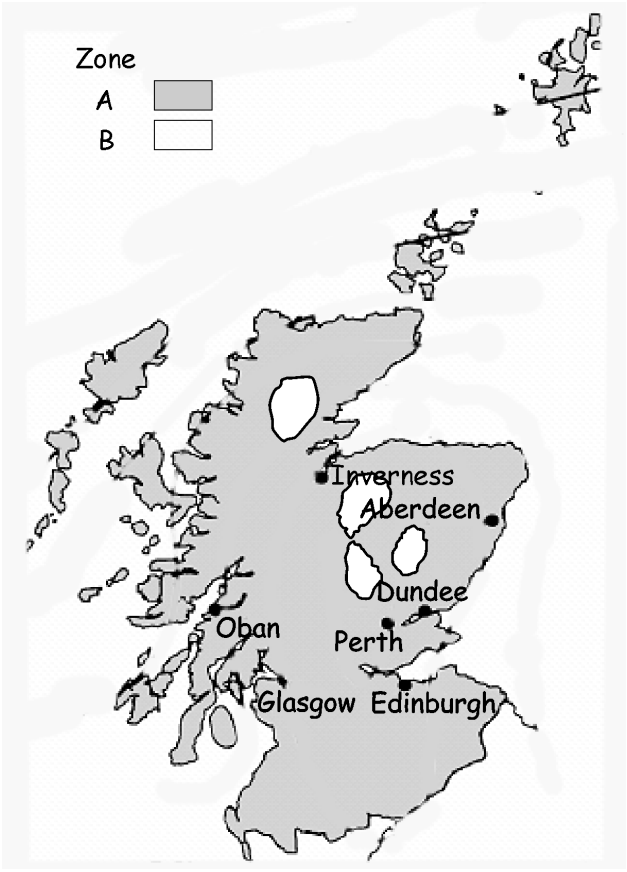
The table below gives indications of typical *dead loads* on floors and roofs.

Construction	Dead load (kN/m^2)
Floors	
Floor boards, 12.5 mm plasterboard	0.22
Floor boards, 19 mm plasterboard	0.27
Floating floor, 18 mm plywood deck, 100 mm quilt insulation, 12.5 mm plasterboard and 19 mm plasterboard	0.66
Flat roofs	
3 layer felt, 120 mm rigid insulation, vapour layer, 18 mm plywood decking and 12.5 mm plasterboard	0.38
13 mm chippings, 3 layer felt, 120 mm rigid insulation, vapour layer, 22 mm plywood decking and 12.5 mm plasterboard	0.63
Pitched roof	
Concrete tiles, battens and sarking	0.75

Note that the above are based on 600 mm joist centres and excludes the weight of the joists, partitioning and rafters.

1.F.7 Imposed roof loads including snow

The map opposite indicates the zones within Scotland where the snow loading should be not more than the values in the table below, depending on geographical location and altitude.



This guidance applies only to pitched and *flat roofed* structures with the roof on one level only, within the limits set out on the tables to clauses 1.F.9-13, provided that there are no other *buildings* within 1.5 m of its perimeter but does not apply to trussed rafter roofs.

For all other circumstances, reference should be made to BS 6399-3: 1988.

Imposed roof loads (kN/m^2)

Zone	Altitude below 100 m	Altitude between 100m and 200 m	Altitude between 200 m and 260 m
A	0.75	1.00	Refer to BS 6399-3: 1988
B	1.00	1.50	1.50

1.F.8 Spans, sizes and centres for timber members

The following table refers to further tables and diagrams with accompanying notes that give spans, sizes and centres for certain timber floor, *flat roof* and pitched roof members. In clauses 1.F.9-13 all spans, except those for floorboards, are measured as the clear dimensions between supports.

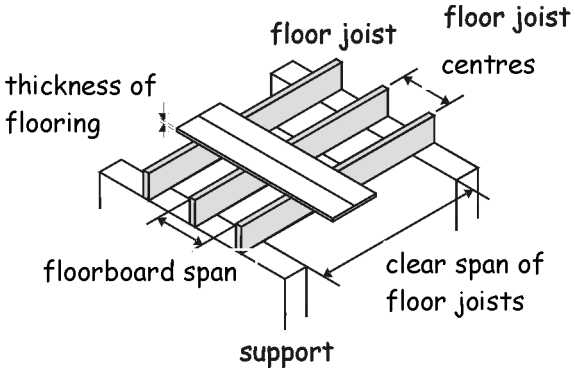
Key to tables relating to timber members

Construction	Timber members	Table number for strength classes	
		C16	C24
Floors	Joists	1.F.9	1.F.9
Flat roofs - access for maintenance only	Joists	1.F.10	1.F.10
Flat roofs - full access allowed	Joists	1.F.11	1.F.11
Raised tie roofs	All	1.F.12	1.F.12
Collared roofs	All	1.F.13	1.F.13

1.F.9 Floor joists

The tables below give sizes, centres and spans for floor joists which should support the *dead loads* given in the tables and an *imposed load* not more than 1.5 kN/m^2:

a. partition loads have not been allowed for (refer to clause 1.F.16);
b. softwood tongued and grooved floorboards, if supported at joist centres of up to 450 mm, should be at least 16 mm thick; and if supported at wider centres not more than 600 mm, should be at least 19 mm thick;
c. wood chipboard, type P5, if supported at joist centres of not more than 450 mm, should be at least 18 mm thick and if supported at wider centres up to 600 mm, should be at least 22 mm thick;
d. floor joists selected from these tables may be used for intermediate floors in timber frame *construction* but will require header joists around the perimeter;
e. T & G chipboard flooring should be fixed by 3.35 mm x 65 mm angular ring shank nails at 200 mm centres around the perimeter and 300 mm centres intermediately and glued with PVA adhesive between boards and joists to boards to prevent creaking (per BS 8103-3: 1996).



Permissible clear spans, in metres, of joists supporting floors with no partitions
Timber strength class C16

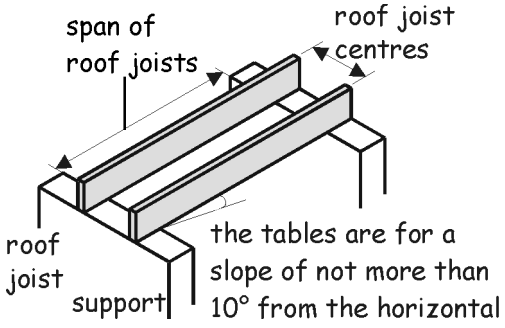
Size of joist (mm x mm)	Dead load not more than 0.25 kN/m^2			Dead load more than 0.25 but not more than 0.50 kN/m^2			Dead load more than 0.50 but not more than 1.25 kN/m^2		
	Joist centres (mm)								
	400	450	600	400	450	600	400	450	600
BS EN 336: 2003 sizes									
38 x 97	1.83	1.69	1.30	1.72	1.56	1.21	1.42	1.30	1.04
38 x 122	2.48	2.39	1.93	2.37	2.22	1.76	1.95	1.79	1.45
38 x 147	2.98	2.87	2.51	2.85	2.71	2.33	2.45	2.29	1.87
38 x 170	3.44	3.31	2.87	3.28	3.10	2.69	2.81	2.65	2.27
38 x 195	3.94	3.75	3.26	3.72	3.52	3.06	3.19	3.01	2.61
38 x 220	4.43	4.19	3.65	4.16	3.93	3.42	3.57	3.37	2.92
47 x 72	1.32	1.23	0.94	1.27	1.15	0.89	1.09	0.99	0.78
47 x 97	2.02	1.91	1.58	1.92	1.81	1.46	1.67	1.53	1.23
47 x 122	2.66	2.56	2.30	2.55	2.45	2.09	2.26	2.08	1.70
47 x147	3.20	3.08	2.79	3.06	2.95	2.61	2.72	2.57	2.17
47 x 170	3.69	3.55	3.19	3.53	3.40	2.99	3.12	2.94	2.55
47 x 195	4.22	4.06	3.62	4.04	3.89	3.39	3.54	3.34	2.90
47 x 220	4.72	4.57	4.04	4.55	4.35	3.79	3.95	3.74	3.24
63 x 97	2.32	2.20	1.92	2.19	2.08	1.82	1.93	1.84	1.53
63 x 122	2.93	2.82	2.57	2.81	2.70	2.45	2.53	2.43	2.09
63 x 147	3.52	3.39	3.08	3.37	3.24	2.95	3.04	2.92	2.58
63 x 170	4.06	3.91	3.56	3.89	3.74	3.40	3.50	3.37	2.95
63 x 195	4.63	4.47	4.07	4.44	4.28	3.90	4.01	3.85	3.35
63 x 220	5.06	4.92	4.58	4.91	4.77	4.37	4.51	4.30	3.75
75 x 122	3.10	2.99	2.72	2.97	2.86	2.60	2.68	2.58	2.33
75 x 147	3.72	3.58	3.27	3.56	3.43	3.13	3.22	3.09	2.81
75 x 170	4.28	4.13	3.77	4.11	3.96	3.61	3.71	3.57	3.21
75 x 195	4.83	4.70	4.31	4.68	4.52	4.13	4.24	4.08	3.65
75 x 220	5.27	5.13	4.79	5.11	4.97	4.64	4.74	4.60	4.07
CLS/ALS sizes									
38 x 89	1.62	1.46	1.12	1.50	1.36	1.05	1.26	1.15	0.91
38 x 140	2.84	2.73	2.40	2.72	2.59	2.17	2.33	2.15	1.75
38 x 184	3.72	3.56	3.09	3.53	3.33	2.90	3.02	2.85	2.47
38 x 235	4.71	4.46	3.89	4.43	4.18	3.64	3.80	3.59	3.11

Permissible clear spans, in metres, of joists supporting floors with no partitions
Timber strength class C24

Size of joist (mm x mm)	Dead load not more than 0.25 kN/m²			Dead load more than 0.25 but not more than 0.50 kN/m²			Dead load more than 0.50 but not more than 1.25 kN/m²		
	Joist centres(mm)								
	400	450	600	400	450	600	400	450	600
BS EN 336: 2003 sizes									
38 x 97	1.94	1.83	1.59	1.84	1.74	1.51	1.64	1.55	1.36
38 x 122	2.58	2.48	2.20	2.47	2.37	2.08	2.18	2.07	1.83
38 x 147	3.10	2.98	2.71	2.97	2.85	2.59	2.67	2.56	2.31
38 x 170	3.58	3.44	3.13	3.43	3.29	2.99	3.08	2.96	2.68
38 x 195	4.10	3.94	3.58	3.92	3.77	3.42	3.53	3.39	3.07
38 x 220	4.61	4.44	4.03	4.41	4.25	3.86	3.97	3.82	3.46
47 x 72	1.40	1.32	1.14	1.35	1.27	1.10	1.22	1.16	1.01
47 x 97	2.14	2.03	1.76	2.03	1.92	1.68	1.80	1.71	1.50
47 x 122	2.77	2.66	2.42	2.65	2.55	2.29	2.38	2.27	2.01
47 x 147	3.33	3.20	2.91	3.19	3.06	2.78	2.87	2.75	2.50
47 x 170	3.84	3.69	3.36	3.67	3.54	3.21	3.31	3.18	2.88
47 x 195	4.39	4.22	3.85	4.20	4.05	3.68	3.79	3.64	3.30
47 x 220	4.86	4.73	4.33	4.71	4.55	4.14	4.26	4.10	3.72
63 x 97	2.43	2.32	2.03	2.31	2.19	1.93	2.03	1.93	1.71
63 x 122	3.05	2.93	2.67	2.92	2.81	2.55	2.63	2.53	2.27
63 x 147	3.67	3.52	3.21	3.50	3.37	3.07	3.16	3.04	2.76
63 x 170	4.21	4.06	3.70	4.04	3.89	3.54	3.64	3.51	3.19
63 x 195	4.77	4.64	4.23	4.61	4.45	4.05	4.17	4.01	3.65
63 x 220	5.20	5.06	4.73	5.05	4.91	4.56	4.68	4.51	4.11
75 x 122	3.22	3.10	2.83	3.09	2.97	2.71	2.78	2.68	2.43
75 x 147	3.86	3.72	3.39	3.70	3.57	3.25	3.34	3.22	2.93
75 x 170	4.45	4.29	3.91	4.27	4.11	3.75	3.86	3.71	3.38
75 x 195	4.97	4.83	4.47	4.82	4.69	4.29	4.41	4.25	3.86
75 x 220	5.42	5.27	4.93	5.25	5.11	4.78	4.88	4.74	4.35
CLS/ALS sizes									
38 x 89	1.71	1.62	1.40	1.63	1.54	1.34	1.46	1.39	1.20
38 x 140	2.96	2.84	2.58	2.83	2.72	2.47	2.54	2.44	2.17
38 x 184	3.87	3.72	3.38	3.70	3.56	3.23	3.33	3.20	2.90
38 x 235	4.85	4.71	4.31	4.70	4.54	4.12	4.24	4.08	3.70

1.F.10 Joists for flat roofs with access only for the purposes of maintenance or repair

The tables below give sizes, centres and spans for *flat roof* joists designed for access only for maintenance which should support the *dead loads* given in the tables and an *imposed load* not more than 0.75 kN/m² or an imposed concentrated load of 0.9 kN.



Permissible clear spans, in metres, of joists for flat roofs with access only for maintenance or repair purposes

Timber strength class C16

Size of joist (mm x mm)	Dead load not more than 0.25 kN/m^2			Dead load more than 0.25 but not more than 0.50 kN/m^2			Dead load more than 0.50 but not more than 1.25 kN/m^2		
	Joist centres(mm)								
	400	450	600	400	450	600	400	450	600
BS EN 336: 2003 sizes									
38 x 97	1.74	1.72	1.67	1.67	1.64	1.58	1.61	1.58	1.51
38 x 122	2.37	2.34	2.25	2.25	2.21	2.11	2.16	2.11	2.01
38 x 147	3.02	2.97	2.85	2.85	2.80	2.66	2.72	2.66	2.51
38 x 170	3.63	3.57	3.37	3.41	3.34	3.17	3.24	3.17	2.98
38 x 195	4.30	4.23	3.86	4.03	3.94	3.63	3.81	3.72	3.45
38 x 220	4.94	4.76	4.34	4.64	4.49	4.09	4.38	4.27	3.88
47 x 72	1.27	1.26	1.23	1.23	1.21	1.18	1.19	1.18	1.13
47 x 97	1.92	1.90	1.84	1.84	1.81	1.74	1.77	1.74	1.65
47 x 122	2.60	2.57	2.47	2.47	2.43	2.31	2.36	2.31	2.19
47 x 147	3.30	3.25	3.12	3.12	3.06	2.90	2.96	2.90	2.74
47 x 170	3.96	3.89	3.61	3.72	3.64	3.40	3.53	3.44	3.23
47 x 195	4.68	4.53	4.13	4.37	4.28	3.89	4.14	4.04	3.70
47 x 220	5.28	5.09	4.65	4.99	4.81	4.38	4.75	4.58	4.17
63 x 97	2.19	2.16	2.09	2.09	2.06	1.97	2.01	1.97	1.87
63 x 122	2.95	2.91	2.79	2.79	2.74	2.61	2.66	2.61	2.47
63 x 147	3.72	3.66	3.44	3.50	3.43	3.25	3.33	3.26	3.07
63 x 170	4.44	4.35	3.97	4.16	4.07	3.74	3.95	3.85	3.56
63 x 195	5.14	4.96	4.54	4.86	4.69	4.28	4.61	4.47	4.07
63 x 220	5.77	5.57	5.10	5.46	5.27	4.82	5.21	5.02	4.59
75 x 122	3.17	3.12	3.00	3.00	2.94	2.80	2.86	2.80	2.65
75 x 147	3.98	3.92	3.64	3.75	3.67	3.44	3.56	3.48	3.27
75 x 170	4.74	4.58	4.19	4.44	4.33	3.96	4.21	4.11	3.77
75 x 195	5.42	5.23	4.79	5.13	4.95	4.53	4.89	4.72	4.31
75 x 220	6.00	5.87	5.38	5.76	5.56	5.09	5.50	5.30	4.85
CLS/ALS sizes									
38 x 89	1.54	1.53	1.48	1.48	1.46	1.41	1.43	1.41	1.35
38 x 140	2.84	2.79	2.68	2.68	2.63	2.51	2.56	2.51	2.37
38 x 184	4.01	3.94	3.64	3.76	3.68	3.43	3.56	3.48	3.25
38 x 235	5.27	5.08	4.63	4.98	4.79	4.36	4.73	4.56	4.14

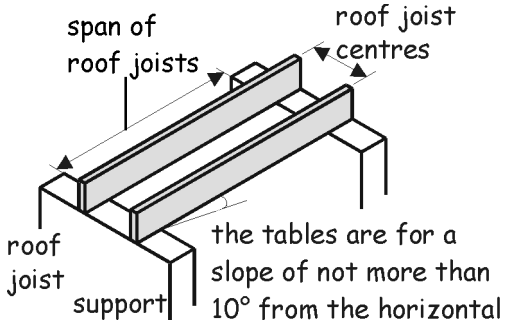
Permissible clear spans, in metres, of joists for flat roofs with access only for maintenance or repair purposes

Timber strength class C24

Size of joist (mm x mm)	Dead load not more than 0.25 kN/m^2			Dead load more than 0.25 but not more than 0.50 kN/m^2			Dead load more than 0.50 but not more than 1.25 kN/m^2		
	Joist centres (mm)								
	400	450	600	400	450	600	400	450	600
BS EN 336: 2003 sizes									
38 x 97	1.84	1.82	1.76	1.76	1.73	1.66	1.69	1.66	1.59
38 x 122	2.50	2.46	2.37	2.37	2.33	2.22	2.27	2.22	2.11
38 x 147	3.18	3.13	3.00	3.00	2.94	2.79	2.85	2.79	2.64
38 x 170	3.81	3.75	3.50	3.58	3.51	3.30	3.40	3.32	3.12
38 x 195	4.51	4.40	4.01	4.22	4.13	3.78	3.99	3.90	3.59
38 x 220	5.13	4.95	4.51	4.85	4.67	4.25	4.59	4.44	4.04
47 x 72	1.35	1.33	1.30	1.30	1.28	1.24	1.26	1.24	1.19
47 x 97	2.03	2.00	1.94	1.94	1.91	1.83	1.86	1.83	1.74
47 x 122	2.74	2.70	2.60	2.60	2.55	2.43	2.48	2.43	2.30
47 x 147	3.47	3.42	3.26	3.27	3.21	3.04	3.11	3.04	2.87
47 x 170	4.15	4.08	3.76	3.89	3.81	3.54	3.69	3.61	3.36
47 x 195	4.88	4.70	4.29	4.58	4.44	4.05	4.33	4.22	3.85
47 x 220	5.48	5.29	4.83	5.18	5.00	4.56	4.94	4.76	4.33
63 x 97	2.31	2.28	2.20	2.20	2.16	2.07	2.11	2.07	1.97
63 x 122	3.10	3.05	2.93	2.93	2.88	2.74	2.80	2.74	2.59
63 x 147	3.90	3.84	3.58	3.67	3.60	3.38	3.49	3.41	3.21
63 x 170	4.65	4.51	4.12	4.35	4.26	3.89	4.13	4.03	3.70
63 x 195	5.33	5.15	4.71	5.05	4.87	4.45	4.82	4.64	4.24
63 x 220	5.98	5.78	5.30	5.67	5.47	5.00	5.41	5.22	4.76
75 x 122	3.33	3.27	3.14	3.14	3.08	2.93	2.99	2.93	2.77
75 x 147	4.17	4.10	3.78	3.92	3.84	3.57	3.73	3.64	3.40
75 x 170	4.92	4.75	4.35	4.64	4.50	4.11	4.40	4.29	3.92
75 x 195	5.61	5.42	4.97	5.32	5.14	4.70	5.08	4.90	4.48
75 x 220	6.00	6.00	5.59	5.97	5.77	5.28	5.70	5.50	5.04
CLS/ALS sizes									
38 x 89	1.63	1.62	1.57	1.57	1.55	1.49	1.51	1.49	1.42
38 x 140	2.99	2.94	2.82	2.82	2.77	2.63	2.69	2.63	2.49
38 x 184	4.21	4.13	3.79	3.94	3.85	3.57	3.73	3.64	3.39
38 x 235	5.47	5.28	4.81	5.17	4.98	4.54	4.92	4.74	4.31

1.F.11 Joists for flat roofs access not limited to maintenance or repair purposes

The tables below give sizes, centres and spans for *flat roof* joists designed for access not limited to maintenance or repair purposes which should support the *dead loads* given in the Tables and an *imposed load* not more than 1.5 kN/m^2 or an imposed concentrated load of 1.8 kN.



Permissible clear spans, in metres, of joists for flat roofs with access not limited to maintenance or repair purposes

Timber strength class C16

Size of joist (mm x mm)	Dead load not more than 0.25 kN/m^2			Dead load more than 0.25 but not more than 0.50 kN/m^2			Dead load more than 0.50 but not more than 1.25 kN/m^2		
	Joist centres(mm)								
	400	450	600	400	450	600	400	450	600
BS EN 336: 2003 sizes									
38 x 97	1.21	1.20	1.18	1.18	1.16	1.13	1.15	1.13	1.09
38 x 122	1.80	1.79	1.74	1.74	1.71	1.65	1.68	1.65	1.57
38 x 147	2.35	2.33	2.27	2.27	2.25	2.18	2.21	2.18	2.09
38 x 170	2.88	2.85	2.77	2.77	2.74	2.64	2.68	2.64	2.53
38 x 195	3.47	3.43	3.29	3.33	3.28	3.16	3.21	3.16	3.02
38 x 220	4.08	4.03	3.71	3.90	3.84	3.56	3.75	3.68	3.43
47 x 72	0.87	0.86	0.85	0.85	0.84	0.83	0.83	0.83	0.80
47 x 97	1.44	1.43	1.40	1.40	1.36	1.36	1.38	1.36	1.21
47 x 122	2.00	1.99	1.94	1.94	1.93	1.87	1.89	1.87	1.81
47 x 147	2.60	2.58	2.51	2.51	2.48	2.40	2.44	2.40	2.31
47 x 170	3.18	3.14	3.06	3.06	3.02	2.91	2.95	2.91	2.78
47 x 195	3.82	3.78	3.54	3.66	3.61	3.40	3.52	3.46	3.28
47 x 220	4.48	4.38	3.99	4.27	4.20	3.83	4.10	4.03	3.70
63 x 97	1.67	1.66	1.63	1.63	1.61	1.57	1.59	1.57	1.53
63 x 122	2.31	2.29	2.24	2.24	2.21	2.15	2.17	2.15	2.07
63 x 147	2.98	2.95	2.87	2.87	2.84	2.74	2.78	2.74	2.63
63 x 170	3.62	3.59	3.41	3.48	3.43	3.28	3.36	3.30	3.16
63 x 195	4.34	4.29	3.90	4.15	4.08	3.75	3.99	3.92	3.62
63 x 220	5.00	4.82	4.39	4.82	4.64	4.22	4.62	4.48	4.08
75 x 122	2.50	2.48	2.42	2.42	2.40	2.32	2.35	2.32	2.24
75 x 147	3.23	3.19	3.11	3.11	3.07	2.96	3.00	2.96	2.84
75 x 170	3.91	3.87	3.61	3.75	3.69	3.47	3.61	3.55	3.35
75 x 195	4.66	4.53	4.13	4.45	4.36	3.97	4.28	4.20	3.84
75 x 220	5.28	5.09	4.65	5.09	4.90	4.47	4.92	4.74	4.32
CLS/ALS sizes									
38 x 89	1.04	1.03	1.01	1.01	1.00	0.98	0.99	0.98	0.95
38 x 140	2.19	2.17	2.12	2.12	2.10	2.04	2.07	2.04	1.94
38 x 184	3.21	3.17	3.08	3.08	3.04	2.93	2.98	2.93	2.80
38 x 235	4.45	4.36	3.96	4.24	4.18	3.80	4.07	4.00	3.65

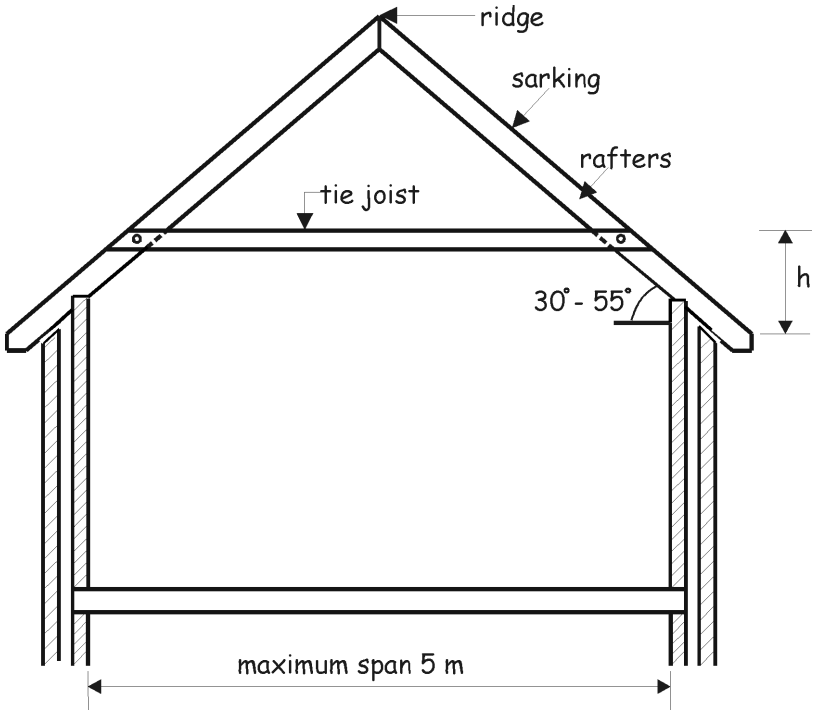
Permissible clear spans, in metres, of joists for flat roofs with access not limited to maintenance or repair purposes

Timber strength class C24

Size of joist (mm x mm)	Dead load not more than 0.25 kN/m^2			Dead load more than 0.25 but not more than 0.50 kN/m^2			Dead load more than 0.50 but not more than 1.25 kN/m^2		
	Joist centres (mm)								
	400	450	600	400	450	600	400	450	600
BS EN 336: 2003 sizes									
38 x 97	1.37	1.36	1.34	1.34	1.33	1.30	1.31	1.30	1.26
38 x 122	1.91	1.90	1.86	1.86	1.84	1.79	1.81	1.79	1.73
38 x 147	2.49	2.46	2.40	2.40	2.38	2.30	2.33	2.30	2.21
38 x 170	3.04	3.01	2.93	2.93	2.89	2.79	2.83	2.79	2.67
38 x 195	3.66	3.62	3.43	3.51	3.46	3.29	3.38	3.33	3.18
38 x 220	4.30	4.25	3.86	4.10	4.04	3.71	3.94	3.87	3.58
47 x 72	0.98	0.98	0.97	0.97	0.96	0.94	0.95	0.94	0.92
47 x 97	1.53	1.52	1.49	1.49	1.48	1.44	1.46	1.44	1.40
47 x 122	2.12	2.10	2.06	2.06	2.04	1.98	2.00	1.98	1.91
47 x 147	2.75	2.73	2.66	2.66	2.62	2.54	2.57	2.54	2.44
47 x 170	3.35	3.32	3.22	3.22	3.18	3.06	3.11	3.06	2.93
47 x 195	4.03	3.98	3.68	3.85	3.80	3.54	3.71	3.64	3.42
47 x 220	4.71	4.56	4.15	4.49	4.39	3.99	4.31	4.23	3.85
63 x 97	1.77	1.75	1.72	1.72	1.71	1.66	1.68	1.66	1.61
63 x 122	2.44	2.42	2.36	2.36	2.34	2.27	2.30	2.27	2.18
63 x 147	3.15	3.12	3.03	3.03	2.99	2.89	2.93	2.89	2.77
63 x 170	3.82	3.78	3.54	3.66	3.61	3.41	3.53	3.47	3.29
63 x 195	4.56	4.45	4.06	4.36	4.29	3.90	4.19	4.11	3.77
63 x 220	5.19	5.00	4.56	5.00	4.82	4.39	4.84	4.66	4.24
75 x 122	2.64	2.26	2.56	2.56	2.53	2.45	2.48	2.45	2.36
75 x 147	3.40	3.36	3.25	3.27	3.23	3.11	3.16	3.11	2.98
75 x 170	4.11	4.07	3.75	3.94	3.88	3.61	3.79	3.73	3.49
75 x 195	4.79	4.70	4.29	4.67	4.53	4.13	4.49	4.38	3.99
75 x 220	5.48	5.28	4.83	5.28	5.09	4.65	5.11	4.93	4.49
CLS/ALS sizes									
38 x 89	1.20	1.20	1.18	1.18	1.17	1.15	1.16	1.15	1.12
38 x 140	2.32	2.30	2.25	2.25	2.22	2.16	2.19	2.16	2.08
38 x 184	3.39	3.35	3.24	3.25	3.21	3.09	3.14	3.09	2.95
38 x 235	4.69	4.54	4.12	4.46	4.36	3.96	4.28	4.20	3.82

1.F.12 Raised tie roof

The tables below give member sizes for raised tie roofs designed for access limited to maintenance or repair purposes which should support *dead load* not more than 0.75 kN/m^2 and an *imposed load* not more than 1.5 kN/m^2 for truss centres of not more than 600 mm and a span not more than 5 m.



Timber of strength class C16

Rafter size (mm x mm)	Tie joist size (mm x mm)	Max h (mm)
47 × 220	47 × 220	575
47 × 195	47 × 195	450
47 × 195	47 × 195	325

Timber of strength class C24 (TR26)

Rafter size (mm x mm)	Tie joist size (mm x mm)	Max h (mm)
47 × 170 or 38 x 195	47 × 170 or 38 x 195	575
38 x 195	38 x 195	450
38 x 195	38 × 195	325

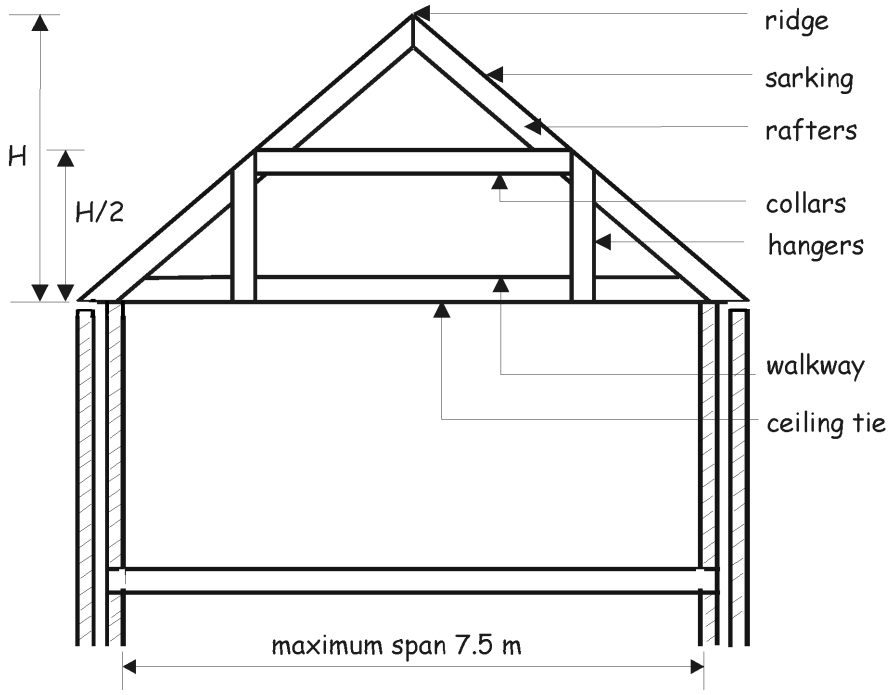
Notes:

1. roof bracing should be in accordance with BS 5268-3: 2006; and
2. masonry walls should be cavity walls in accordance with annex 1.D; and
3. connection details should be as in clause 1.F.14; and
4. rafters to be tied down to walls in accordance with clause 1.E.40.

1.F.13 Collared roof

The tables below give member sizes for collared roofs designed for access limited to maintenance or repair purposes which should support *dead loads* not more than 0.75 kN/m^2 and *imposed load* not more than 1.5 kN/m^2 for truss centres not more than 600 mm and a span not more than 7.5 m.

Roof space is for access only with an *imposed load* on to the ceiling ties of not more than 0.25 kN/m^2 together with a concentrated load of 0.9 kN and does not include for water tanks.



Timber of strength class C16

Centres (mm)	Rafter size (mm x mm)	Ceiling tie (mm x mm)	Collar size (mm x mm)	Hanger size (mm x mm)
400	47 x 147	47 x 147	47 x 97	47 x 97
450	47 x 195	47 x 195	47 x 122	47 x 122
600	47 x 220	47 x 220	47 x 147	47 x 147

Timber of strength class C24 (TR26)

Centres (mm)	Rafter size (mm x mm)	Ceiling tie (mm x mm)	Collar size (mm x mm)	Hanger size (mm x mm)
400	47 x 147	47 x 147	47 x 97	47 x 97
450	47 x 147	47 x 147	47 x 122	47 x 122
600	47 x 195	47 x 195	47 x 147	47 x 147

Notes:

1. roof bracing should be in accordance with BS 5268-3: 2006; and
2. masonry walls should be cavity walls in accordance with annex 1.D; and
3. connection details should be as in clause 1.F.14; and
4. trusses to be tied down to walls in accordance with clause 1.E.40.

1.F.14 Connection details for raised tied and collared roofs

Connections for raised and collared roofs should be:

- 450 mm rafter centres: 38 mm diameter double sided toothed connector and M10, grade 4.6 bolts should be used; or
- 600 mm rafter centres: 51 mm diameter double sided toothed connector and M12, grade 4.6 bolts should be used.

1.F.15 Openings for stairs

Where openings in floors are required for stairs:

a. the perimeter of the opening should be supported on all sides by load bearing walls; or
b. the floor joists should be strengthened by means of additional joists and trimmers as follows:
    - doubling up the trimming joists either side of the openings in floors parallel to the floor joists and connecting them together (e.g. nailed) over the full length of the joists and supporting similarly other joists at either end (i.e. using joist hangers or built-in);
    - installing trimmer joists perpendicular to floor joists comprising two joists (of similar size to the trimming joists) joined together and supported by means of joist hangers connected to the trimming joists.

The plan size of openings for stairs should be not more than 2.70 m parallel to the floor joists by 1.15 m perpendicular to the floor joists.

1.F.16 Supports to non load-bearing partitions

Provided lightweight partitions comprising timber studs lined on each side with 12.5 mm plasterboard are used the following should be provided:

a. where the partition is parallel to the floor joists and directly above a floor joist, an additional joist should be used alongside the main joist;
b. where the partition is parallel to the floor joists but not directly above a floor joist, an extra joist should be used below the partition;
c. where the partition is perpendicular to the floor joists and the joists are at no more than 600 mm centres no additional supports are required.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