AS 4055:2021

Wind loads for housing

AS 4055:2021

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Wind loads for housing

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Preface

This Standard was prepared by the Standards Australia Committee BD-099, Wind loads for housing, to supersede AS 4055:2012.

The objective of this document is to provide designers, builders and manufacturers of building products that are affected by wind loading with a range of wind speed classes that can be used to design and specify such products for use in housing that are within the limits of this document.

This revision aims to improve modelling of topographic effects and also to harmonize with recent changes to AS/NZS 1170.2.

The major changes in this edition are as follows:

(a) The scope has been revised to include the limitation to NCC Class 1 and 10a buildings. This has always been the intention of this document as reflected in the definition of *house* (1.4.4), but the limitation is more obvious when presented in the Scope.

(b) The wind speeds for each wind classification remain unchanged.

(c) Table 2.2 has been updated to include revision to AS/NZS 1170.2 which allows interpolation of wind speed between the boundaries of cyclonic regions C and D.

(d) Figure 1.2 has been modified to clarify definition of height of house when house site has batters (e.g. retaining walls) adjacent to the house.

(e) Definitions for terrain categories (see Clause 2.3) have been revised to align with those in AS/NZS 1170.2 and to clarify the differences between the categories.

(f) The calculation of topographic class (see Clause 2.4) had previously used the maximum slope of the topographic feature. The revision has been made to explicitly use the derived maximum slope that runs through the house site. The diagram of the cross-section of a hill better shows the measurements required to assess topographic class.

(g) The example of topographic classes in Appendix B has been changed to reflect the definition of topographic classes.

(h) The example of terrain categories and shielding in Appendix C has been changed to reflect the definition of terrain categories and shielding.

(i) Nomenclature of "r" and "w" has been added to the wind classifications (see Clause 2.6) which is used to evaluate roof and wall pressures, including elements on openings such as windows and doors. No change has been made to the pressures used for each classification.

(j) Tables 5.2(B) to 5.2(M) have been amended to address minor discrepancies between values in the previous edition and those calculated from the formulae in Appendix A.

The figures in Appendix A have been reproduced with permission from Department of Resources, Queensland © State of Queensland 2021.

The term "informative" has been used in this Standard to define the application of the Appendix to which it applies. An "informative" appendix is only for information and guidance.

Notes to the text contain information and guidance only and are not an integral part of the document.

Contents

NOTES

Australian Standard®

Wind loads for housing

Section 1 Scope and general

1.1 Scope

This document specifies site wind speed classes for determining design wind speeds and wind loads for NCC Class 1 and 10a buildings within the geometric limits given in Clause 1.2. The classes are for use in the design of housing and for design, manufacturing and specifying of building products and systems used for housing.

Wind loads for NCC Class 1 and 10a buildings that are not within the geometric limits given in Clause 1.2 and other NCC building classes, i.e. Class 2 to 9 buildings, are outside the scope of this document.

NOTE 1 Commentary on the clauses of this document is given in Appendix A.

NOTE 2 A worked example for the determination of topography is given in Appendix B.

NOTE 3 Worked examples for the determination of terrain category and shielding class are given in Appendix C.

NOTE 4 A worked example for racking forces is given in Appendix D.

NOTE 5 Refer to AS/NZS 1170.2 for buildings that are outside the geometric and other limitations of this document.

1.2 Geometric limits

For the purpose of this document, the following conditions (geometric limits) shall apply (see Figure 1.2):

(a) The distance from averaged ground level to the underside of eaves shall not exceed 6.0 m.

(b) The distance from averaged ground level to the highest point of the roof, not including chimneys, shall not exceed 8.5 m.

(c) The width (W) including roofed verandas, excluding eaves up to a maximum of 0.9 m, shall not exceed 16.0 m. The length (L) shall not exceed five times the width.

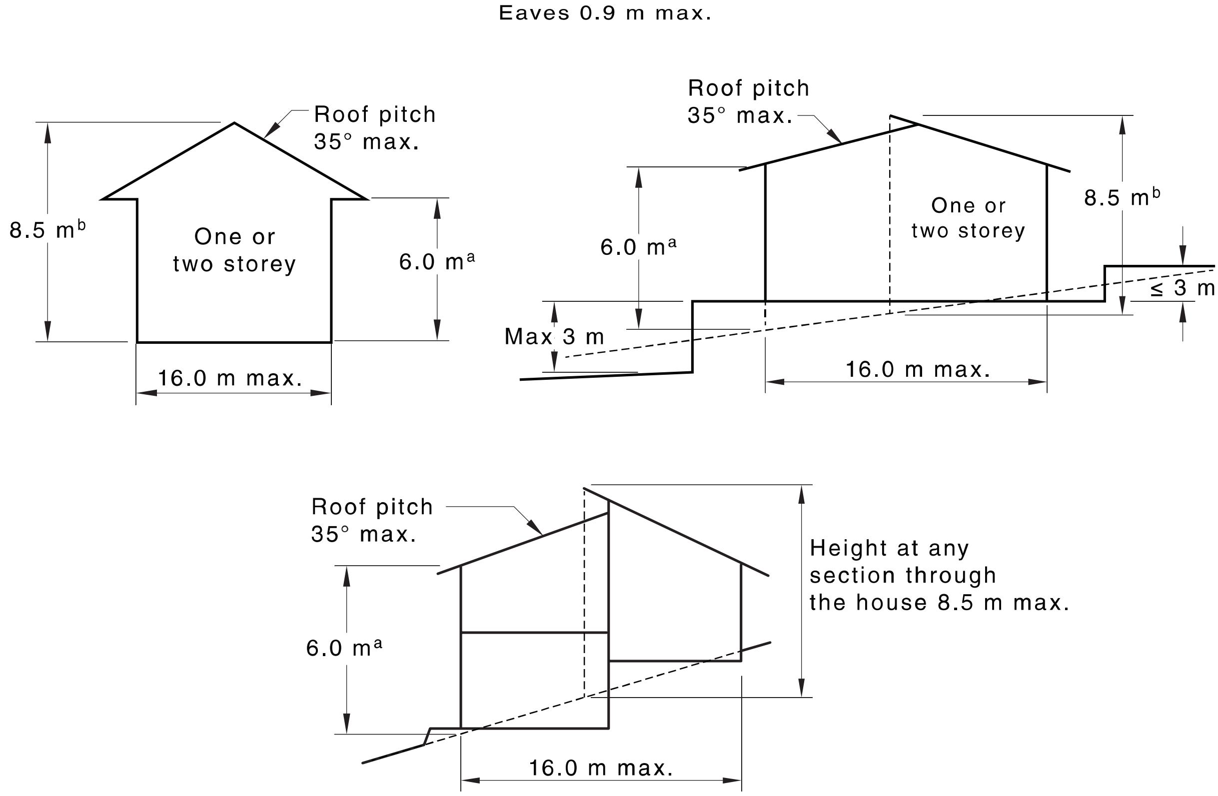
(d) The roof pitch shall not exceed 35°.

NOTE 1 The tables in Section 5 are based on a floor to ceiling height of 2.4 m and a floor depth of 0.3 m (floor level down to ceiling below).

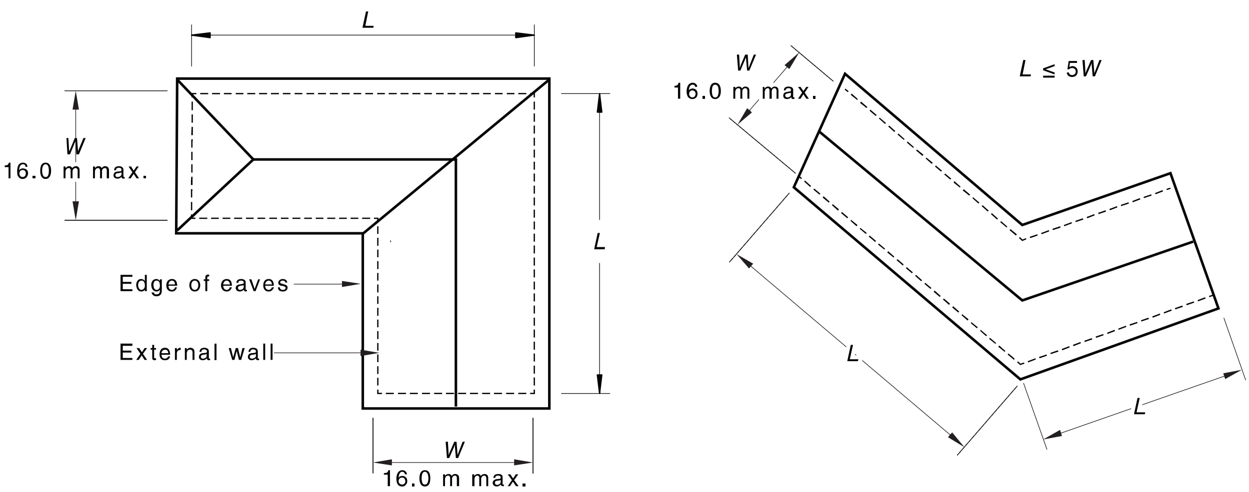
Where wind loads on houses are determined using this document, design parameters shall be derived from this document only. Where wind loads on buildings are determined using AS/NZS 1170.2, design parameters in that Standard only shall be used.

NOTE 2 Clause 3.2.3 refers to pressures on solar panels given in AS/NZS 1170.2. These parameters are referenced in this document.

Dimensions in metres



(a) Sections



(b) Plan view

NOTE The *averaged ground level* (1.4.1) is represented by the dashed ground lines in the cross-sections.

Figure 1.2 — Geometry

1.3 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS/NZS 1170.2, *Structural design actions, Part 2: Wind actions*

1.4 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1.4.1
averaged ground level
natural ground level excluding earthworks where earthworks are minor, or averaged ground level through modified land where the earthworks are major

Note 1 to entry: Where minor earthworks have changed the level of the land over less than 50 m^2, see lower cross-section in Figure 1.2(a).

Note 2 to entry: Where major earthworks have changed the level of the land over more than 50 m^2, see upper right cross-section in Figure 1.2(a).

1.4.2
bottom of hill, ridge or escarpment
area at the base of the hill, ridge or escarpment, where the average slope is less than 1 in 20

1.4.3
height
distance from ground level to the underside of eaves or to the highest point of the roof neglecting chimneys; or the height of each storey at external walls

Note 1 to entry: See Figure 1.2.

1.4.4
house
NCC Class 1 or 10a building with the geometric limitations specified in Clause 1.2

1.4.5
length
maximum overall distance between outside edges of the external walls of a house or shape

Note 1 to entry: See Figure 1.2.

1.4.6
may
indicates the existence of an option

1.4.7
obstruction
natural or man-made objects that generate turbulent wind flow, ranging from single trees to forests and from isolated small structures to closely spaced multi-storey buildings

1.4.8
plan
basic rectangular, square or L-shaped layout, or simple combinations of these layouts

Note 1 to entry: See Figure 1.2.

1.4.9
racking forces
forces that occur in walls parallel to the wind direction

1.4.10
shall
indicates that a statement is mandatory

1.4.11
should
indicates a recommendation

1.4.12
width
maximum distance from wall to wall in the direction perpendicular to the length, including roofed verandas but excluding eaves

Note 1 to entry: See Figure 1.2.

1.5 Notation

Unless otherwise stated, the notation used in this document shall have the following meaning:

C1 to C4	=	cyclonic wind classes
$\mathrm{C1_{serv}}$ to $\mathrm{C4_{serv}}$	=	cyclonic wind classes for serviceability
C_{p}	=	pressure coefficient (external, internal or net, as appropriate)
$C_{\mathrm{p,e}}$	=	external pressure coefficient
$C_{\mathrm{p,i}}$	=	internal pressure coefficient
$C_{\mathrm{p,n}}$	=	net pressure coefficient
d	=	average horizontal distance measured from the crest of the escarpment or hill to the near top-third zone, in metres
FS, PS, NS	=	shielding classes, full shielding, partial shielding and no shielding
G	=	dead load; or permanent action (self-weight), in kilopascals
G	=	wind pressure zone more than 1 200 mm from edges of roofs or external corners of walls
H	=	height of a hill, ridge or escarpment, in metres
H_0	=	maximum distance from the ground to the underside of the bearer in the lower floor, in metres
h	=	average roof height, in metres
h_0	=	half the height of the wall (half of the floor to ceiling height) in metres
K_{c}	=	combination factor
K_{l}	=	local pressure factor
L, M, T	=	lower, middle and top third of hill, ridge or escarpment

L	=	length of a house; or lower part of a hill, ridge or escarpment, in metres
L_u	=	horizontal distance upwind from the crest of the hill, ridge or escarpment to a level half the height below the crest
M_s	=	shielding multiplier
M_t	=	topographic multiplier
$M_{6.5,cat}$	=	terrain category multiplier at height (h)
N1 to N6	=	non-cyclonic wind classes
$N1_{serv}$ to $N6_{serv}$	=	non-cyclonic wind classes for serviceability
p	=	design wind pressure acting normal to a surface, in kilopascals
q_u	=	free stream dynamic gust pressure, in kilopascals
NA	=	not applicable
RC	=	pressure zone on roofs within 1 200 mm of external corners
RE	=	pressure zone on roofs within 1 200 mm of roof panel edges
SC	=	pressure zone on walls within 1 200 mm of external corners of the house
TC1 to TC3	=	terrain categories
T0 to T5	=	topographic classes
V_h	=	design gust wind speed at height (h), in metres per second
$V_{h,s}$	=	design gust wind speed at height (h) for serviceability limit state, in metres per second
$V_{h,u}$	=	design gust wind speed at height (h) for ultimate strength limit state, in metres per second
W	=	width of a house, in metres
W_s	=	serviceability wind action, in kilopascals
W_u	=	ultimate wind action in kilopascals
α	=	angle of roof pitch
ϕ_a	=	maximum slope through the top half of the hill, ridge or escarpment
γ	=	load factor
ρ_{air}	=	density of air

Section 2 Wind loads

2.1 Site wind classification

The system of 10 site wind classifications is set out in Tables 2.1(A) and 2.1(B) together with the associated site design gust wind speeds (V_h) for the serviceability and ultimate limit states. This incorporates both non-cyclonic (N) and cyclonic (C) winds.

Table 2.1(A) — Design gust wind speed (V_h) for non-cyclonic Regions A and B

Site wind classification	Design gust wind speed (V_h) at height (h) m/s	
	Serviceability limit state ($V_{h,s}$)	Ultimate limit state ($V_{h,u}$)
N1	26	34
N2	26	40
N3	32	50
N4	39	61
N5	47	74
N6	55	86

Table 2.1(B) — Design gust wind speed (V_h) for cyclonic Regions C and D

Site wind classification	Design gust wind speed (V_h) at height (h) m/s	
	Serviceability limit state ($V_{h,s}$)	Ultimate limit state ($V_{h,u}$)
C1	32	50
C2	39	61
C3	47	74
C4	55	86

NOTE Section 3 may present different pressures for the same wind speed depending on classification.

2.2 Relationship to wind region and site conditions

The selection of site wind classification for a house depends on the conditions at the site of the house. The classification shall be determined from Table 2.2 using the following site conditions determined as stated:

(a) Geographic wind region of the site as defined in Figure 2.2 (Region A, B, C or Region D, as given in AS/NZS 1170.2).

(b) The terrain category that surrounds or is likely to surround the site within the next five years, as defined in Clause 2.3, e.g. TC1, TC2, TC2.5 or TC3.

(c) The topographic class of the site, as defined in Clause 2.4, e.g. T0, T1, T2, T3, T4 or T5.

(d) The shielding class of the house, as defined in Clause 2.5, e.g. FS, PS or NS.

For cyclonic wind Regions C and D, the site wind classification is a function of the distance (km) from the coast or wind region boundary closest to the coast.

For wind Region C in Western Australia, inland from wind Region D, the distance given in Table 2.4 is the distance (km) to the boundary between wind Region C and wind Region D, elsewhere in wind Region C, it is the distance to the smoothed coast line.

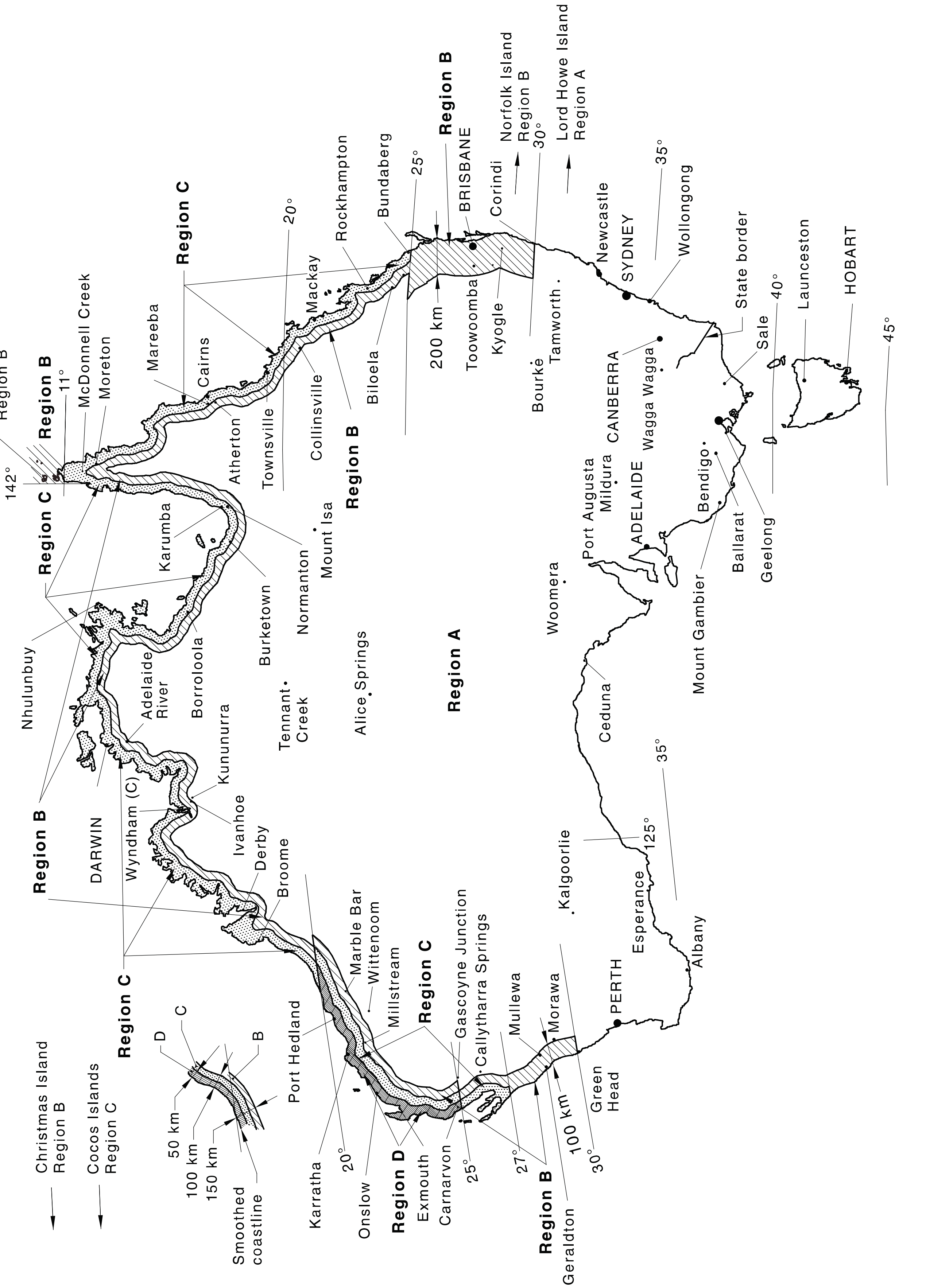

Christmas Island
Region B
Cocos Islands
Region C
Smoothed coastline
50 km
100 km
150 km
D
C
B
Region C
Region B
Region D
Region A
Torres Strait Islands
Region B
142°
11°
McDonnell Creek
Moreton
Mareeba
Cairns
Atherton
Townsville
Collinsville
Mackay
Rockhampton
Biloela
Bundaberg
25°
20°
BRISBANE
200 km
Toowoomba
Kyogle
Corindi
Norfolk Island
Region B
Lord Howe Island
Region A
30°
Tamworth
Bourke
Newcastle
SYDNEY
Wollongong
35°
CANBERRA
Wagga Wagga
State border
Sale
40°
Launceston
HOBART
45°
Bendigo
Ballarat
Geelong
Mount Gambier
ADELAIDE
Mildura
Port Augusta
Woomera
Ceduna
Mount Isa
Normanton
Karumba
Burketown
Alice Springs
Tennant Creek
Borroloola
Nhulunbuy
Adelaide River
DARWIN
Kununurra
Wyndham (C)
Ivanhoe
Derby
Broome
Marble Bar
Wittenoom
Millstream
Port Hedland
Karratha
Onslow
Exmouth
Carnarvon
Gascoyne Junction
Callytharra Springs
Mullewa
Morawa
Geraldton
27°
100 km
Green Head
PERTH
Kalgoorlie
Esperance
Albany
125°

Figure 2.2 — Boundaries of Regions A, B, C and D

[SOURCE: AS/NZS 1170.2.]

NOTE 1 Regions are marked with the letters A, B, C and D.

NOTE 2 Coastal region boundaries are smooth lines set in from a smoothed coastline by 50 km, 100 km, 150 km and 200 km.

NOTE 3 Islands within 50 km of the coast are designated in the same region as the adjacent coast.

Table 2.2 — Site wind classification from wind region and site conditions

Wind region	TC	Topographic classification												
		T0	T0	T0	T1	T1	T1	T2	T2	T2	T3	T3	T4	T5
		FS	PS	NS	FS	PS	NS	FS	PS	NS	PS	NS	NS	NS
A	**3**	N1	N1	N1	N1	N2	N2	N2	N2	N2	N3	N3	N3	N4
	2.5	N1	N1	N2	N1	N2	N2	N2	N3	N3	N3	N3	N4	N4
	2	N1	N2	N2	N2	N2	N3	N2	N3	N3	N3	N3	N4	N4
	1	N2	N2	N3	N2	N3	N3	N3	N3	N3	N4	N4	N4	N5
B	**3**	N2	N2	N3	N2	N3	N3	N3	N3	N4	N4	N4	N4	N5
	2.5	N2	N3	N3	N3	N3	N3	N3	N4	N4	N4	N4	N5	N5
	2	N2	N3	N3	N3	N3	N4	N3	N4	N4	N4	N5	N5	N6
	1	N3	N3	N4	N3	N4	N4	N4	N4	N5	N5	N5	N6	N6
C	**3**	C1 (0-50)	C2 (0-10) C1 (10-50)	C2 (0-20) C1 (20-50)	C2 (0-5) C1 (5-50)	C2 (0-30) C1 (30-50)	C2 (0-40) C1 (40-50)	C2 (0-25) C1 (25-50)	C3 (0-5) C2 (5-50)	C3 (0-20) C2 (20-50)	C3 (0-25) C2 (25-50)	C3 (0-30) C2 (30-50)	C4 (0-10) C3 (10-50)	C4 (0-35) C3 (35-50)
	2.5	C1 (0-50)	C2 (0-25) C1 (25-50)	C2 (0-35) C1 (35-50)	C2 (0-20) C1 (20-50)	C2 (0-40) C1 (40-50)	C3 (0-10) C2 (10-50)	C2 (0-35) C1 (35-50)	C3 (0-20) C2 (20-50)	C3 (0-30) C2 (30-50)	C3 (0-35) C2 (35-50)	C4 (0-5) C3 (5-50)	C4 (0-25) C3 (25-50)	NA (0-15) C4 (15-50)
	2	C2 (0-10) C1 (10-50)	C2 (0-35) C1 (35-50)	C2 (0-45) C1 (45-50)	C2 (0-30) C1 (30-50)	C3 (0-10) C2 (10-50)	C3 (0-25) C2 (25-50)	C3 (0-10) C2 (10-50)	C3 (0-30) C2 (30-50)	C3 (0-40) C2 (40-50)	C4 (0-10) C3 (10-50)	C4 (0-20) C3 (20-50)	NA (0-5) C4 (5-50)	NA (0-25) C4 (25-50)
	1	C2 (0-30) C1 (30-50)	C3 (0-10) C2 (10-50)	C3 (0-25) C2 (25-50)	C3 (0-10) C2 (10-50)	C3 (0-30) C2 (30-50)	C4 (0-5) C3 (5-50)	C3 (0-25) C2 (25-50)	C4 (0-10) C3 (10-50)	C4 (0-20) C3 (20-50)	C4 (0-30) C3 (30-50)	NA (0-5) C4 (5-50)	NA (0-25) C4 (25-50)	NA (0-45) C4 (45-50)

Table 2.2 *(continued)*

Wind region	TC	Topographic classification												
		T0	T0	T0	T1	T1	T1	T2	T2	T2	T3	T3	T4	T5
		FS	PS	NS	FS	PS	NS	FS	PS	NS	PS	NS	NS	NS
D	3	C2 (0-30) C1 (30-50)	C3 (0-10) C2 (10-50)	C3 (0-25) C2 (25-50)	C3 (0-5) C2 (5-50)	C3 (0-35) C2 (35-50)	C3 (0-50)	C3 (0-30) C2 (30-50)	C4 (0-5) C3 (5-50)	C4 (0-20) C3 (20-50)	C4 (0-30) C3 (30-50)	C4 (0-40) C3 (40-50)	NA (0-25) C4 (25-50)	NA (0-50)
	2.5	C2 (0-50)	C3 (0-25) C2 (25-50)	C3 (0-40) C2 (40-50)	C3 (0-25) C2 (25-50)	C3 (0-50)	C4 (0-15) C3 (15-50)	C3 (0-45) C2 (45-50)	C4 (0-25) C3 (25-50)	C4 (0-40) C3 (40-50)	NA (0-5) C4 (5-50)	NA (0-20) C4 (20-50)	NA (0-40) C4 (40-50)	NA (0-50)
	2	C3 (0-10) C2 (10-50)	C3 (0-40) C2 (40-50)	C4 (0-5) C3 (5-50)	C3 (0-35) C2 (35-50)	C4 (0-15) C3 (15-50)	C4 (0-30) C3 (30-50)	C4 (0-10) C3 (10-50)	C4 (0-40) C3 (40-50)	NA (0-15) C4 (15-50)	NA (0-20) C4 (20-50)	NA (0-35) C4 (35-50)	NA (0-50)	NA (0-50)
	1	C3 (0-35) C2 (35-50)	C4 (0-15) C3 (15-50)	C4 (0-30) C3 (30-50)	C4 (0-10) C3 (10-50)	C4 (0-40) C3 (40-50)	NA (0-15) C4 (15-50)	C4 (0-35) C3 (35-50)	NA (0-25) C4 (25-50)	NA (0-40) C4 (40-50)	NA (0-45) C4 (45-50)	NA (0-50)	NA (0-50)	NA (0-50)

Key

FS = Full shielding

PS = Partial shielding

NS = No shielding

NOTE For wind Regions C and D, site wind classification is given according to the distance (km) from the smoothed boundary (coastline or higher wind region).

2.3 Selection of terrain category

The terrain category (TC) for a housing site is a measure of the lowest effective surface roughness from any radial direction within a distance of 500 m of the proposed housing site. It may be based on the likely terrain five years after design. Substantial well-established trees may be considered as obstructions for evaluation of terrain category in all wind regions.

NOTE 1 In assessing the terrain category, a reasonable estimate should be made about infill development in the next five years as it is the anticipated development five years after construction that is assessed.

The terrain category for a housing site shall be identified by the notation TC1, TC2, TC2.5 or TC3 and be determined as follows:

(a) *Terrain Category 1 (TC1)* — Very exposed open terrain with very few or no obstructions, and all water surfaces, e.g. flat, treeless, poorly grassed plains; open ocean, rivers, canals, bays and lakes.

(b) *Terrain Category 2 (TC2)* — Open terrain including grassland with well-scattered obstructions having heights generally from 1.5 m to 5 m with no more than two obstructions per hectare, e.g. farmland and cleared subdivisions with isolated trees or clumps of trees, equivalent to at least house size, and uncut grass.

(c) *Terrain Category 2.5 (TC2.5)* — Terrain with a few trees or isolated obstructions. This category is intermediate between TC2 and TC3 and represents the terrain in developing outer urban areas with scattered houses or clumps of trees equivalent to house size, or large acreage developments with fewer than 10 house-size obstructions per hectare.

(d) *Terrain Category 3 (TC3)* — Terrain with numerous closely spaced obstructions having heights generally from 3 m to 10 m. The minimum density of obstructions shall be at least the equivalent of 10 house-size obstructions per hectare, e.g. suburban housing, light industrial estates or clumps of trees greater than house size.

In urban situations, roads, rivers, small lakes or canals less than 200 m wide shall be deemed to form part of normal "Terrain Category 3" terrain. Parks and other open spaces less than 250 000 m^2 in area shall also be deemed to form part of normal "Terrain Category 3" terrain provided they are not within 500 m of each other or not within 500 m of open country.

Housing sites less than 500 m from the edge of a development shall be classified as the applicable terrain that adjoins the development, i.e. TC1, TC2, TC2.5 or TC3, as applicable.

NOTE 2 Shielding provisions may still apply to these sites.

NOTE 3 For commentary on terrain categories, see Appendix A.

NOTE 4 For worked examples, see Appendix C.

NOTE 5 Terrain Category 4, as defined in AS/NZS 1170.2, is not applicable to this document.

NOTE 6 Terrain categories are the same as those in AS/NZS 1170.2.

NOTE 7 Vegetation is considered differently for terrain categories in this clause and for shielding classes in Clause 2.5.

2.4 Selection of topographic class

The topographic class is a measure of the effect of wind on a house on rising ground.

The topographic class for a housing site shall be identified by the notation T0, T1, T2, T3, T4 or T5 and be determined from Table 2.4.

NOTE For a worked example to determine topographic class, see Appendix B.

The slope (ϕ_a) shall be the steepest measured slope in the top half of the cross-section through the site.

The bottom of the cross-section shall be that area at the bottom of the hill, ridge or escarpment where the average slope is less than 1 in 20 (e.g. creek, river valley or flat area) and does not continue further downwards at an average slope of more than 1 in 20 for at least 200 m, see Figure 2.4(A).

The top of the cross-section shall be that area at the crest of the hill, ridge or escarpment where the average slope is less than 1 in 20 (e.g. saddle, peak or plateau) and does not continue upwards for at least 200 m, see Figure 2.4(A).

The top-third zone (T) extends for an equal distance (d) either side of the crest of an escarpment as shown in Figure 2.4(B). The value of d shall be the average horizontal distance measured from the crest of the escarpment to the near top-third zone.

A rise in terrain shall be deemed an escarpment where the maximum slope on one side of the ridge is greater than 1 in 10 and on the other side is less than 1 in 20.

Table 2.4 — Topographic classification for hills, ridges or escarpments

Maximum slope		**Site location, see Figures 2.4(A) and 2.4(B)**				
		Lower-third zone	**Mid-third zone**	**Top-third zone (T)**		
(ϕ_a)		**(L)**	**(M)**	**$H \leq 10$ m**	**10 m < $H \leq 30$ m**	**H > 30 m**
< 1:20 (<2.9°)		T0	T0	T0	T0	T0
≥ 1:20 (≥2.9°)	< 1:10 (<5.7°)	T0	T0	T1	T1	T1
≥ 1:10 (≥5.7°)	< 1:7.5 (<7.6°)	T0	T1	T1	T2	T2
≥ 1:7.5 (≥7.6°)	< 1:5 (<11.3°)	T0	T1	T2	T2	T3
≥ 1:5 (≥11.3°)	< 1:3 (<18.4°)	T0	T2	T2	T3	T4
≥ 1:3 (≥18.4°)		T0	T2	T3	T4	T5

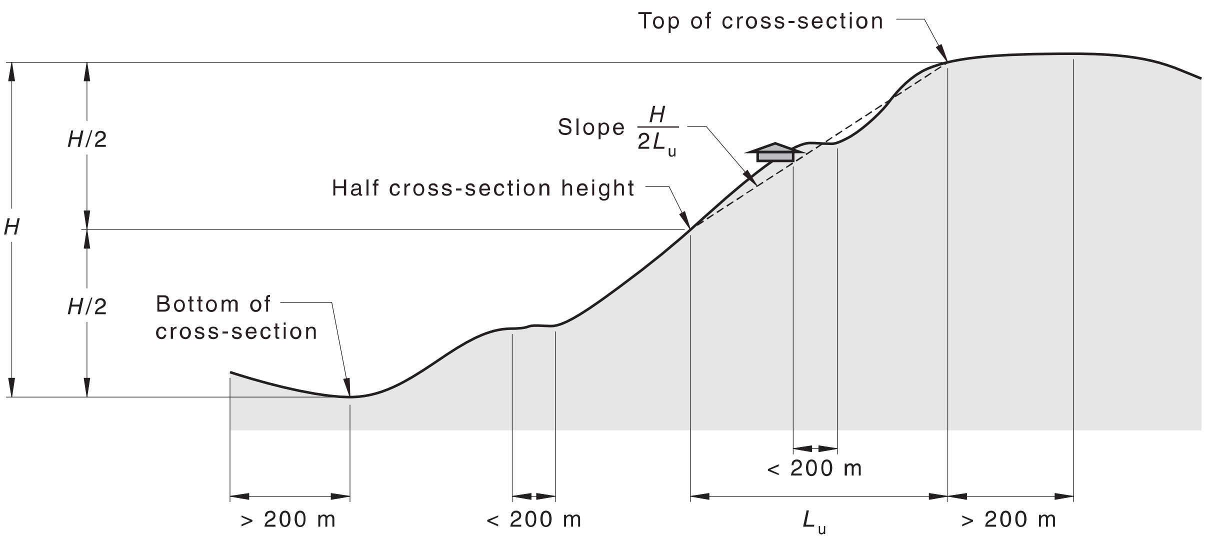


Figure 2.4(A) — Topographic zones for top and bottom of slope

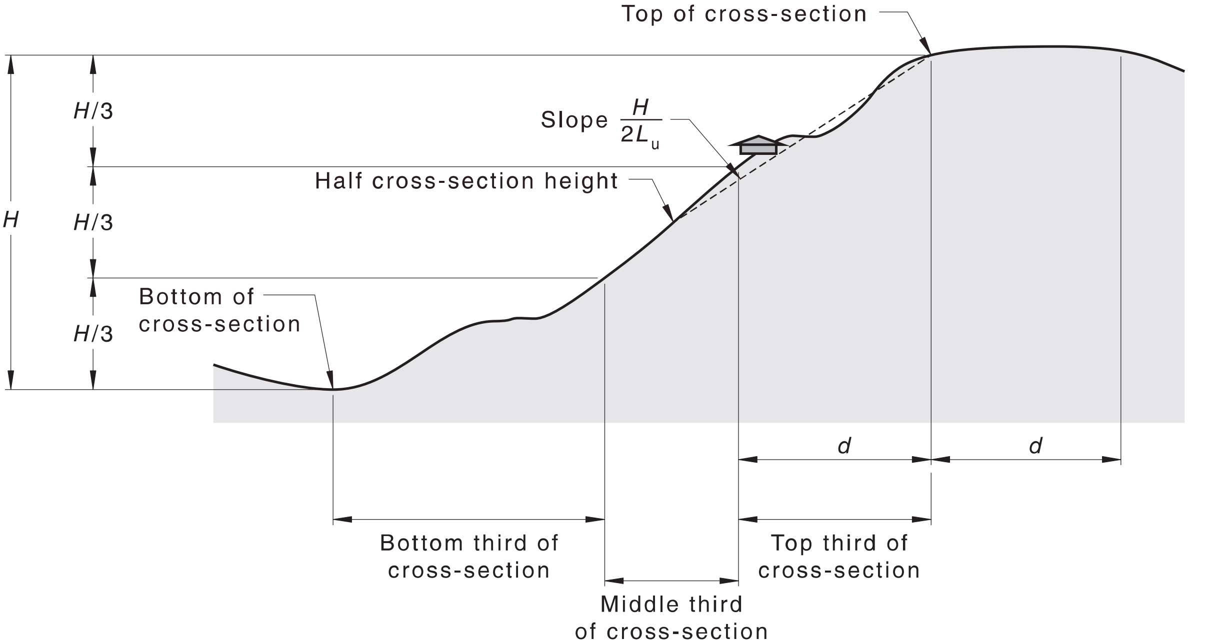


Figure 2.4(B) — Topographic zones for average slope

2.5 Selection of shielding class

The shielding class is a measure of the effect of surrounding buildings, or similar size obstructions, on the wind speed at the site. It may be based on the anticipated shielding five years after design.

NOTE 1 In Regions A and B, trees or groups of trees with similar face area to houses may be considered as shielding elements.

In Regions C and D, trees and vegetation shall not be used as shielding elements.

The shielding class for a housing site shall be identified by the notation FS, PS or NS, and be determined as follows:

(a) *Full shielding (FS)* — Full shielding shall apply where there are no open areas within 100 m of the site and at least two rows of houses or similar-sized permanent obstructions surround the house being considered. In Regions A and B, permanent, closely spaced trees with a height greater than the proposed house and extending equivalent to three rows of houses, shall be determined to provide full shielding. Full shielding shall be only for houses within Topographic Classes T0, T1 and T2.

The application of full shielding shall be appropriate for typical suburban development greater than or equal to 10 houses, or similar size obstructions per hectare.

NOTE 2 The effects of road reserves or other small open areas with a width of less than 20 m adjacent to the house site may be ignored.

(b) *Partial shielding (PS)* — Partial shielding shall apply to intermediate situations where there are at least 2.5 houses or sheds per hectare, such as acreage type suburban development. Partial shielding shall be only for houses within Topographic Classes T0, T1, T2 and T3.

NOTE 3 The second row of houses abutting open parkland, open water or airfields may be classified as having partial shielding.

NOTE 4 In Regions A and B, permanent, closely spaced trees with a height greater than the proposed house and extending equivalent to two rows of houses provide partial shielding.

(c) *No shielding (NS)* — No shielding shall apply where there are no permanent obstructions or where there are less than 2.5 obstructions per hectare, such as the row of houses or single houses abutting open parklands, open water or airfields.

NOTE 5 For commentary on shielding class, see Appendix A.

NOTE 6 For worked examples, see Appendix C.

NOTE 7 In assessing shielding, a reasonable estimate should be made about infill development in the next five years as it is the anticipated development five years after construction that is assessed.

2.6 Wall and roof wind classifications

2.6.1 General

The wall and roof wind classifications shall be determined using Table 2.6.1(A) or Table 2.6.1(B) from the site wind classification, taking into account the features of the house to be placed on the site.

Table 2.6.1(A) — Wall and roof classifications for houses in wind Regions A and B

Site wind classification	Wall classification	Roof classification
N1	N1w	N1r
N2	N2w	N2r
N3	N3w	N3r
N4	N4w	N4r
N5	N5w	N5r
N6	N6w	N6r
NOTE For the purpose of this version, nomenclature of “r” and “w” has been added to the wind classifications which is used to evaluate roof and wall pressures, including elements on openings such as windows and doors. No change has been made to pressures for each classification. For example, a N1r rating for roofing means N1 rated roofing and similarly a N1w rating for windows means N1 rated windows.		

Table 2.6.1(B) — Wall and roof classifications for houses in wind Regions C and D

Site wind classification	Wall classification	Roof classification
C1	C1w	C1r
C2	C2w	C2r
C3	C3w	C3r
C4	C4w	C4r
NOTE For the purpose of this version, nomenclature of “r” and “w” has been added to the wind classifications which is used to evaluate roof and wall pressures, including elements on openings such as windows and doors. No change has been made to pressures for each classification. For example, a C1r rating for roofing means C1 rated roofing and similarly a C1w rating for windows means C1 rated windows.		

2.6.2 Use of wind classifications

The elements shall be classified as follows:

(a) Wall cladding and structural elements shall be specified using the wall classification given in Tables 2.6.1(A) and 2.6.1(B).

(b) Roof cladding and structural elements shall be specified using the roof classification given in Tables 2.6.1(A) and 2.6.1(B).

(c) Other items on the site shall be specified using the site classification given in Tables 2.6.1(A) and 2.6.1(B).

(d) Bracing forces shall be specified using the site classification, see Section 5.

Section 3 Calculation of pressures and forces

3.1 Pressure zones

The following external pressure zones [see Figures 3.1(A) and 3.1(B)] shall be used in evaluating wind loads on houses:

(a) *General (G)* — Areas of roofs more than 1 200 mm from edges, and areas of walls (including windows and doors) more than 1 200 mm from external corners.

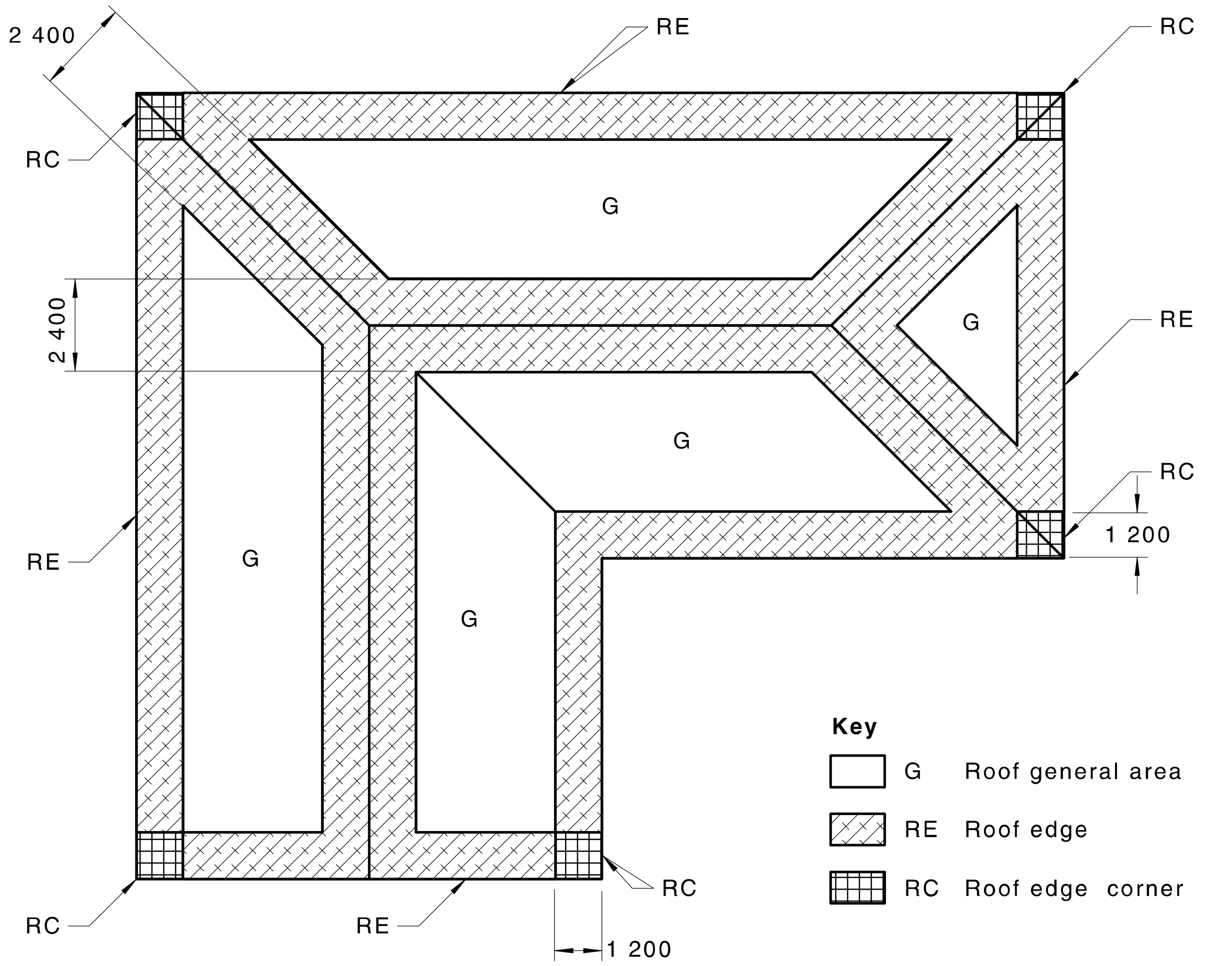
(b) *Roof edge (RE)* — Areas of roofs within 1 200 mm of all edges except the external corners of the roof.

(c) *Roof corners (RC)* — Areas of the external corners of roofs within 1 200 mm of two adjacent edges.

NOTE This is the overlap area between two RE zones.

(d) *Walls near corners (SC)* — Walls (including windows and doors) at external corners of the house within 1 200 mm of the corner.

Dimensions in millimetres



NOTE Indicated plan width varies to suit roof pitch.

Figure 3.1(A) — Pressure zones on housing — Roofs (plan view)

Dimensions in millimetres

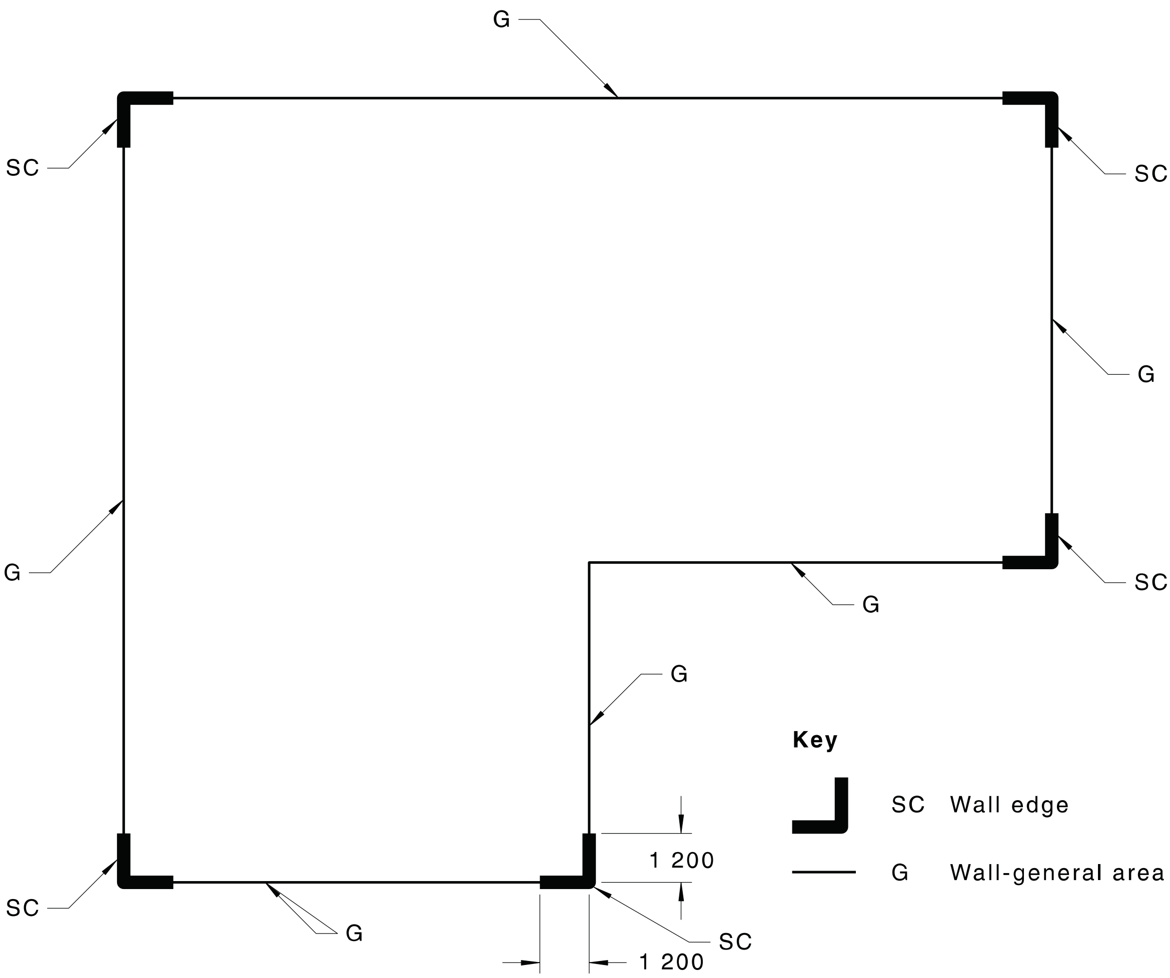


Figure 3.1(B) — Pressure zones on housing — Walls (plan view)

3.2 Pressure coefficients

3.2.1 Roof and wall wind classifications N1 to N6 (non-cyclonic)

For houses with roof and wall wind classifications N1 to N6 (in Regions A and B), the pressure coefficients in Table 3.2.1 shall be used.

Table 3.2.1 — Pressure coefficients for roof and wall wind classifications N1 to N6 (Regions A and B for ultimate strength and serviceability)

Housing component		Factored external pressure coefficient ($K_l.C_{p,e}$)	Internal pressure coefficient ($C_{p,i}$)	Net pressure coefficient ($K_c.C_{p,n}$)
Roof — General areas, see Region G in Figure 3.1(A)				
(a)	General, including all trusses and rafters	−0.9 +0.4	+0.2 −0.3	−1.0 +0.63
(b)	Cladding, fasteners and immediate supporting members not within 1 200 mm of edges	−0.9 +0.4	+0.2 −0.3	−1.0 +0.63
Roof — Edges				
(c)	Cladding, fasteners and immediate supporting members within 1200 mm of edges, see Region RE in Figure 3.1(A)	−1.8	+0.2	−1.8
(d)	Cladding, fasteners and immediate supporting members within 1200 mm of eaves corners (applies to roof slopes less than 10°), see Region RC in Figure 3.1(A)	−2.7	+0.2	−2.61
Walls				
(a)	General, including all studs, see Region G in Figure 3.1(B)	+0.7 −0.65	−0.3 +0.2	+0.9 −0.77
(b)	Cladding, fasteners, doors and windows not within 1200 mm of edges, see Region G in Figure 3.1(B)	−0.65 +0.7	+0.2 −0.3	−0.77 +0.9
(c)	Cladding, fasteners, doors and corner windows within 1200 mm of edges, see Region SC in Figure 3.1(B)	−1.3	+0.2	−1.35

NOTE 1 Positive internal or external pressures are towards the surface (negative values are away from the surface — suctions). For net pressures, positive values are inwards net pressures, and negative values are outwards net pressures.

NOTE 2 For roofs, immediate supporting members include battens and purlins. Rafters and trusses are not considered as immediate supporting members.

NOTE 3 The internal pressures may only be used where all elements of the building envelope including the cladding, windows and doors, are able to withstand the design wind pressures.

NOTE 4 Net pressure coefficient includes the effect of a combination factor and so will not equal $K_l.C_{p,e} - C_{p,i}$, see Clause A.4.

NOTE 5 Windows and doors with 25 % or more of the width of a single panel or pane within 1 200 mm of the building edge are classified as SC not G.

3.2.2 Roof and wall wind classifications C1 to C4 (cyclonic)

For houses with roof and wall wind classifications C1 to C4 (in Regions C and D) the pressure coefficients in Tables 3.2.2(A) and 3.2.2(B) shall be used.

Table 3.2.2(A) — Pressure coefficients for roof and wall wind classifications C1 to C4 (Regions C and D — Cyclonic — For ultimate strength)

Housing component		Factored external pressure coefficient ($K_l.C_{p,e}$)	Internal pressure coefficient ($C_{p,i}$)	Net pressure coefficient ($K_c.C_{p,n}$)
Roof — General areas, see Region G in Figure 3.1(A)				
(a)	General, including all trusses and rafters	−0.9 +0.4	+0.7 −0.65	−1.44 +0.95
(b)	Cladding, fasteners and immediate supporting members not within 1 200 mm of edges	−0.9 +0.4	+0.7 −0.65	−1.44 +0.95
Roof — Edges				
(c)	Cladding, fasteners and immediate supporting members within 1200 mm of edges, see Region RE in Figure 3.1(A)	−1.8	+0.7	−2.25
(d)	Cladding, fasteners and immediate supporting members within 1200 mm of eaves corners (applies to roof slopes less than 10°), see Region RC in Figure 3.1(A)	−2.7	+0.7	−3.06
Walls				
(a)	General, including all studs, see Region G in Figure 3.1(B)	−0.65 +0.7	+0.7 −0.65	−1.22 +1.22
(b)	Cladding, fasteners, doors and windows not within 1200 mm of edges, see Region G in Figure 3.1(B)	−0.65 +0.7	+0.7 −0.65	−1.22 +1.22
(c)	Cladding, fasteners, doors and corner windows within 1200 mm of edges, see Region SC in Figure 3.1(B)	−1.3	+0.7	−1.8

NOTE 1 Positive internal or external pressures are towards the surface (negative values are away from the surface — suctions). For net pressures, positive values are inwards net pressures, and negative values are outwards net pressures.

NOTE 2 For roofs, immediate supporting members include battens and purlins. Rafters and trusses are not considered as immediate supporting members.

NOTE 3 Net pressure coefficient includes the effect of a combination factor and so will not equal $K_l.C_{p,e} - C_{p,i}$, see Clause A.4.

NOTE 4 Windows and doors with 25 % or more of the width of a single panel or pane within 1 200 mm of the building edge are classified as SC not G.

Table 3.2.2(B) — Pressure coefficient for wind classes C1 to C4 (Regions C and D — Cyclonic — For serviceability)

Housing component		Factored external pressure coefficient ($K_l.C_{p,e}$)	Internal pressure coefficient ($C_{p,i}$)	Net pressure coefficient ($K_c.C_{p,n}$)
Roof — General areas, see Region G in Figure 3.1(A)				
(a)	General, including all trusses and rafters	−0.9 +0.4	+0.2 −0.3	−1.0 +0.63
(b)	Cladding, fasteners and immediate supporting members not within 1 200 mm of edges	−0.9 +0.4	+0.2 −0.3	−1.0 +0.63
Roof — Edges				
(c)	Cladding, fasteners and immediate supporting members within 1200 mm of edges, see Region RE in Figure 3.1(A)	−1.8	+0.2	−1.8
(d)	Cladding, fasteners and immediate supporting members within 1200 mm of eaves corners (applies to roof slopes less than 10°), see Region RC in Figure 3.1(A)	−2.7	+0.2	−2.61
Walls				
(a)	General, including all studs, see Region G in Figure 3.1(B)	+0.7 −0.65	−0.3 +0.2	+0.9 −0.77
(b)	Cladding, fasteners and windows not within 1 200 mm of edges, see Region G in Figure 3.1(B)	−0.65 +0.7	+0.2 −0.3	−0.77 +0.9
(c)	Cladding, fasteners and corner windows within 1200 mm of edges, see Region SC in Figure 3.1(B)	−1.3	+0.2	−1.35

NOTE 1 Positive internal or external pressures are towards the surface (negative values are away from the surface — suctions). For net pressures, positive values are inwards net pressures, and negative values are outwards net pressures.

NOTE 2 For roofs, immediate supporting members include battens and purlins. Rafters and trusses are not considered as immediate supporting members.

NOTE 3 Net pressure coefficient includes the effect of a combination factor and so will not equal $K_l.C_{p,e} - C_{p,i}$, see Clause A.4.

NOTE 4 Windows and doors with 25 % or more of the width of a single panel or pane within 1 200 mm of the building edge are classified as SC not G.

3.2.3 Wind pressures on photovoltaic solar panels

Pressures on photovoltaic solar panels for designing their connection to the roof structure shall be in accordance with AS/NZS 1170.2.

3.3 Calculation of pressures

The design wind pressures (p), in kilopascals, shall be determined for structures and parts of structures from the following equation:

$$p = q_u C_p \qquad 3.3$$

where

p = design wind pressure acting normal to a surface, in kilopascals

NOTE: Positive pressures indicate pressures above ambient. Negative pressure indicates pressures below ambient.

q_u = free stream dynamic gust pressure

$= \dfrac{0.5\rho_{air}[V_h]^2}{1000}$

ρ_{air} = density of air, which shall be taken as 1.2 kg/m^3

C_p = pressure coefficient, as given in Clause 3.2 (external, internal or net, as appropriate)

This document does not require evaluation of pressures across internal walls.

NOTE Where design requires pressures across internal walls, refer to AS/NZS 1170.2.

3.4 Calculation of forces

The design wind forces shall be determined for structures and parts of structures by multiplying the pressure by the area under consideration and applying the resultant force at the centre of the area normal to the surface.

NOTE For further information on calculating pressures and forces, refer to AS/NZS 1170.2.

Uplift forces shall be determined by taking the uplift pressure (negative pressure coefficients indicate outward forces on a surface) by the total area of the roof, see Section 4.

Racking forces shall be determined for the overall house by taking the relevant vertical projected area and distributing the force to the bracing walls or panels, as specified in Section 5.

3.5 Pressures for typical applications

Based on the net pressure coefficients in Tables 3.2.1 and 3.2.2(A) and (B), ultimate limit state design pressures (tabulated as "ultimate strength pressure") for the N and C categories shall be as given in Table 3.5(A). Serviceability limit state design pressures (tabulated as serviceability pressure) from N and C categories shall be as given in Table 3.5(B).

All locations in Table 3.5(A) shall be able to resist both positive and negative net pressures. The positive net pressures shall apply to any position on the surface.

NOTE The negative net pressures are given for each pressure zone defined in Clause 3.1 and shown for roofs in Figure 3.1(A) and for walls in Figure 3.1(B).

Table 3.5(A) — Ultimate strength pressures (kPa) for wind classification from the net pressure coefficients given in Clause 3.2

Walls				Roofs				
Wind classification	**Any position**	**Away from corners, see Note 2**	**Within 1 200 mm of corners, see Note 2**	**Wind classification**	**Any position**	**General away from edges, see Note 1**	**Within 1 200 mm of edges, see Note 1**	**At corners within 1 200 mm of both edges, see Note 1**
Pressure zone	**G, SC** Figure 3.1(B)	**G** Figure 3.1(B)	**SC** Figure 3.1(B)	**Pressure zone**	**G, RE, RC** Figure 3.1(A)	**G** Figure 3.1(A)	**RE** Figure 3.1(A)	**RC** Figure 3.1(A)
$K_C.C_{p,n}$	**+0.9**	**−0.77**	**−1.35**	$K_C.C_{p,n}$	**+0.63**	**−0.99**	**−1.8**	**−2.61**
N1w	+0.62	−0.53	−0.94	**N1r**	+0.44	−0.69	−1.25	−1.81
N2w	+0.86	−0.74	−1.30	**N2r**	+0.60	−0.95	−1.73	−2.51
N3w	+1.35	−1.16	−2.03	**N3r**	+0.95	−1.49	−2.70	−3.92
N4w	+2.01	−1.72	−3.01	**N4r**	+1.41	−2.21	−4.02	−5.83
N5w	+2.96	−2.53	−4.44	**N5r**	+2.07	−3.25	−5.91	−8.58
N6w	+3.99	−3.42	−5.99	**N6r**	+2.80	−4.39	−7.99	−11.58
$K_C.C_{p,n}$	**+1.2**	**−1.2**	**−1.8**	$K_C.C_{p,n}$	**+0.95**	**−1.44**	**−2.25**	**−3.06**
C1w	+1.80	−1.80	−2.7	**C1r**	+1.43	−2.16	−3.38	−4.59
C2w	+2.68	−2.68	−4.02	**C2r**	+2.12	−3.21	−5.02	−6.83
C3w	+3.94	−3.94	−5.91	**C3r**	+3.12	−4.73	−7.39	−10.05
C4w	+5.33	−5.33	−7.99	**C4r**	+4.22	−6.39	−9.98	−13.58

NOTE 1 For roofs, net pressures on cladding, fasteners and immediate supporting members (such as battens and purlins) are specific to the pressure zone. Net pressure effects on trusses and rafters can be taken from the net pressures for general zones.

NOTE 2 For walls, net pressures on cladding elements and fasteners (such as wall sheathing, windows and doors) are specific to the pressure zone. Net pressure effects on wall studs and frames can be taken from the net pressures for general zones.

NOTE 3 The design net pressures for eaves and soffit linings are taken as equal to the net pressures applied to adjacent wall surface, e.g. the design pressure for eaves lining within 1 200 mm of a corner for a C2 classification is +2.68 kPa and −4.02 kPa.

NOTE 4 In order to use the internal pressures in the N classifications in this table, all of the cladding elements including windows, doors and garage doors need to be able to withstand the design wind loads.

Table 3.5(B) — Serviceability pressures (kPa) for wind classification from the net pressure coefficients given in Clause 3.2

Walls				Roofs				
Wind classification	**Any position**	**Away from corners, see Note 1**	**Within 1 200 mm of corners, see Note 2**	**Wind classification**	**Any position**	**General away from edges, see Note 1**	**Within 1 200 mm of edges, see Note 1**	**At corners within 1 200 mm of both edges, see Note 1**
Pressure Zone	**G, SC Figure 3.1(B)**	**G Figure 3.1(B)**	**SC Figure 3.1(B)**	**Pressure zone**	**G, RE, RC Figure 3.1(A)**	**G Figure 3.1(A)**	**RE Figure 3.1(A)**	**RC Figure 3.1(A)**
$K_C.C_{p,n}$	**+0.9**	**−0.77**	**−1.35**	$K_C.C_{p,n}$	**+0.63**	**−0.99**	**−1.8**	**−2.61**
N1w$_{serv}$	+0.37	−0.31	−0.55	**N1r$_{serv}$**	+0.26	−0.40	−0.73	−1.06
N2w$_{serv}$	+0.37	−0.31	−0.55	**N2r$_{serv}$**	+0.26	−0.40	−0.73	−1.06
N3w$_{serv}$	+0.55	−0.47	−0.83	**N3r$_{serv}$**	+0.39	−0.61	−1.11	−1.60
N4w$_{serv}$	+0.82	−0.70	−1.23	**N4r$_{serv}$**	+0.57	−0.90	−1.64	−2.38
N5w$_{serv}$	+1.19	−1.02	−1.79	**N5r$_{serv}$**	+0.84	−1.31	−2.39	−3.46
N6w$_{serv}$	+1.63	−1.40	−2.45	**N6r$_{serv}$**	+1.14	−1.80	−3.27	−4.74
$K_C.C_{p,n}$	**+0.9**	**−0.77**	**−1.35**	$K_C.C_{p,n}$	**+0.63**	**−0.99**	**−1.8**	**−2.61**
C1w$_{serv}$	+0.55	−0.47	−0.83	**C1r$_{serv}$**	+0.39	−0.61	−1.11	−1.60
C2w$_{serv}$	+0.82	−0.70	−1.23	**C2r$_{serv}$**	+0.57	−0.90	−1.64	−2.38
C3w$_{serv}$	+1.19	−1.02	−1.79	**C3r$_{serv}$**	+0.84	−1.31	−2.39	−3.46
C4w$_{serv}$	+1.63	−1.40	−2.45	**C4r$_{serv}$**	+1.14	−1.80	−3.27	−4.74

NOTE 1 For roofs, net pressures on cladding, fasteners and immediate supporting members (such as battens and purlins) are specific to the pressure zone. Net pressure effects on trusses and rafters can be taken from the net pressures for general zones.

NOTE 2 For walls, net pressures on cladding elements and fasteners (such as wall sheathing, windows and doors) are specific to the pressure zone. Net pressure effects on wall studs and frames can be taken from the net pressures for general zones.

NOTE 3 The design net pressures for eaves and soffit linings is taken as equal to the net pressures applied to adjacent wall surface.

NOTE 4 The net pressures for all N wind classifications may only be used where all cladding elements including windows and doors need to be able to withstand the design wind loads, see Clause A.4.

Section 4 Uplift forces

Table 4 gives net design uplift pressures for the determination of anchoring requirements at tops of walls. The pressures shall be applied as uplift on the entire roof surface.

Table 4 — Net design uplift pressures (kPa) for determination of anchoring requirements at top of walls

Wind class	Serviceability limit state		Ultimate strength limit state	
	Tile roof	Sheet roof, see Note 4	Tile roof	Sheet roof, see Note 4
N1r	0	0.04	0	0.33
N2r	0	0.04	0.14	0.59
N3r	0	0.25	0.68	1.13
N4r	0	0.54	1.40	1.85
N5r	0.42	0.95	2.44	2.89
N6r	0.90	1.44	3.58	4.03
C1r	0	0.25	1.35	1.80
C2r	0	0.54	2.40	2.85
C3r	0.41	0.95	3.92	4.37
C4r	0.90	1.44	5.58	6.03

NOTE 1 Positive values in this Table indicate a net upward pressure that is to be resisted by tie down details.

NOTE 2 The net design uplift pressures given in Table 4 are based on the following load combinations: (a) Serviceability limit state: $W_s - G$, (b) Ultimate strength limit state: $W_u - \gamma G$.

NOTE 3 W_u and W_s have been calculated as set out in Section 3 where $V_h = V_{h,u}$ or $V_{h,s}$ as appropriate, using the pressure coefficients given in Section 3.

NOTE 4 Load combination factor $\gamma = 0.9$.

NOTE 5 The values for $G = 0.9$ kPa for tile roof and $G = 0.4$ kPa for sheet roof are in accordance with AS 1684.

NOTE 6 Sheet roof includes metal tile roof.

NOTE 7 The net uplift pressures for all N wind classifications presented in this table may only be used where all cladding elements including windows and doors are able to withstand the design wind loads.

Section 5 Racking forces

5.1 General

Racking forces are lateral (horizontal) forces transferred to the foundations through bracing provided for each storey of the house and the subfloor.

The racking forces occur in walls parallel to the wind direction and are calculated from the horizontal component of wind blowing on the external envelope of the house and resisted by bracing walls.

Racking forces shall be calculated as follows:

(a) Determine the wind class as given in Section 2.

(b) Determine area of elevation of the house as given in Clause 5.2.

(c) Determine the wind pressure, as given in Table 5.2(A), for buildings presenting a flat vertical surface to the wind.

(d) Determine the wind pressure, as given in Tables 5.2(B) to 5.2(M), using the width (shorter dimension) of the building and roof pitch of the building being designed.

Pressures are given for single storey and upper storey of two storeys for both long and short sides of the building, and for lower storey of two storeys or subfloor for both long and short sides of the building.

(e) Calculate racking force, in kN, as follows:

Total racking force = Area of elevation (m^2) × Lateral wind pressure (kPa).

The racking force shall be calculated for both directions (long and short sides) of the building. The total racking force for each storey or level of the building shall be determined as the sum of the forces on each of the areas facing the direction in which racking forces are evaluated. Racking forces shall be calculated to address the most adverse loading situation.

NOTE 1 For intermediate values between those given in Tables 5.2(A) to 5.2(M), use linear interpolation.

NOTE 2 For the explanation of Tables 5.2(A) to 5.2(M), see Appendix A.

NOTE 3 For worked examples, see Appendix D.

5.2 Area of elevation

Area of elevation appropriate for calculation of racking forces shall be as shown in Figures 5.2(A) to 5.2(C).

The wind direction used shall be that resulting in the greatest load for the length and width of the building, respectively. As wind can blow from any direction, the elevation used shall be that for the worst direction.

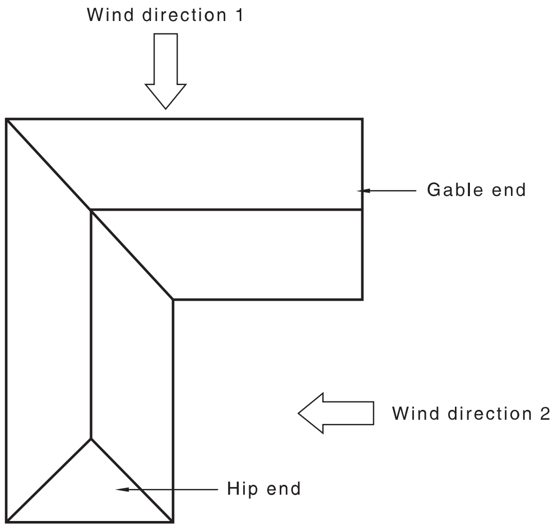
NOTE 1 In the case of a single-storey house with a gable at one end and a hip at the other, the gable end facing the wind will result in a greater amount of load at right angles to the width of the house than the hip end facing the wind.

NOTE 2 For complex building shapes, buildings that are composed of a combination of storeys or rectangles (i.e. L, H or U shapes), the shapes may be considered individually, and forces added together later, or the total area as a whole can be calculated.

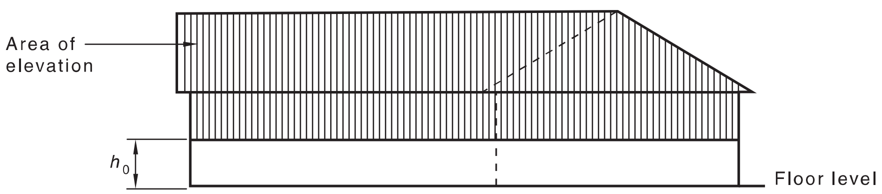
Irrespective of which method is used, racking forces shall be calculated for the most adverse situation.

If a veranda or similar structure is present and is to be enclosed, it shall be included in the "area of elevation" calculations.

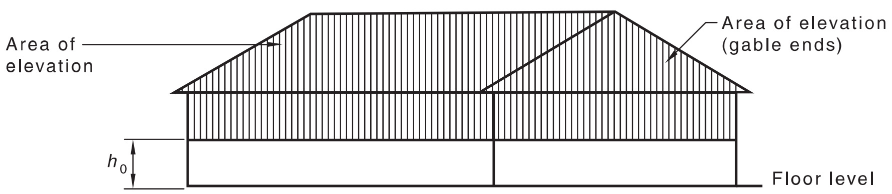
Where there is more than one floor level in a building, each level shall be determined separately for the purpose of calculating the racking forces at each level.



(a) Plan



(b) Wind direction 1



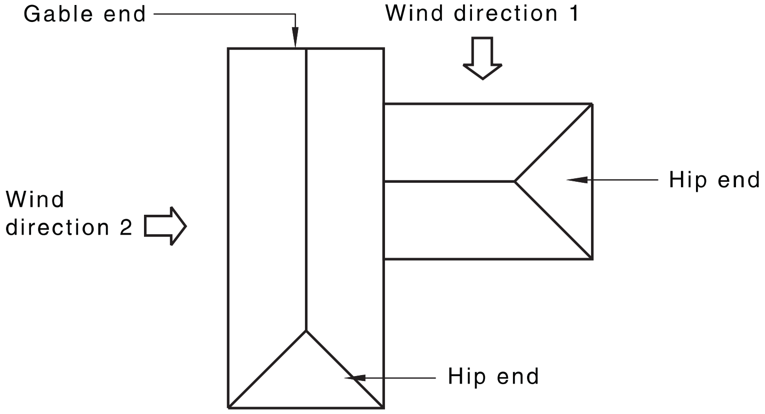
(c) Wind direction 2

NOTE 1 h_0 = half the height of the wall (half the floor to ceiling height).

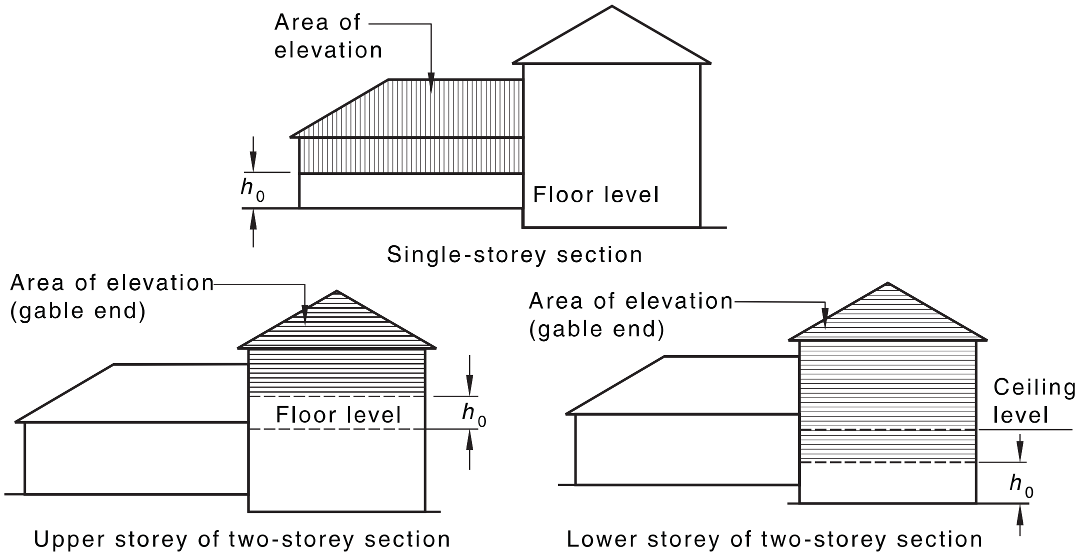
NOTE 2 For lower storey of two-storey section h_0 = half the height of the lower storey, i.e. lower storey floor to lower storey ceiling.

NOTE 3 The area of elevation of the triangular portion of eaves overhang up to 1 000 mm wide may be ignored in the determination of area of elevation.

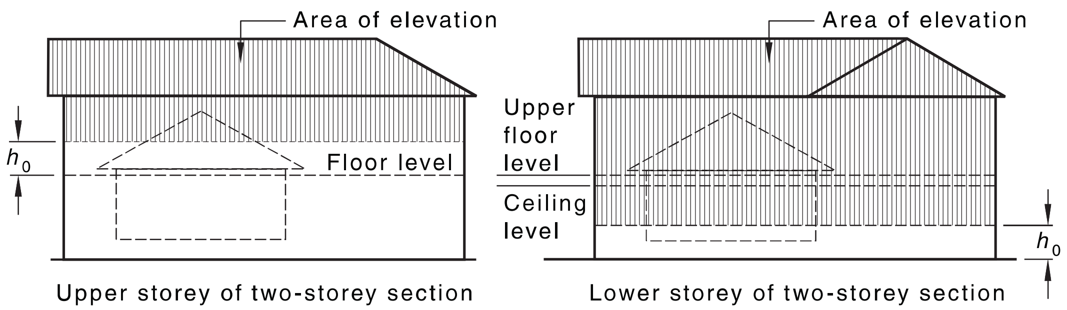
Figure 5.2(A) — Determining area of elevation for a single storey building



(a) Plan



(b) Wind direction 1



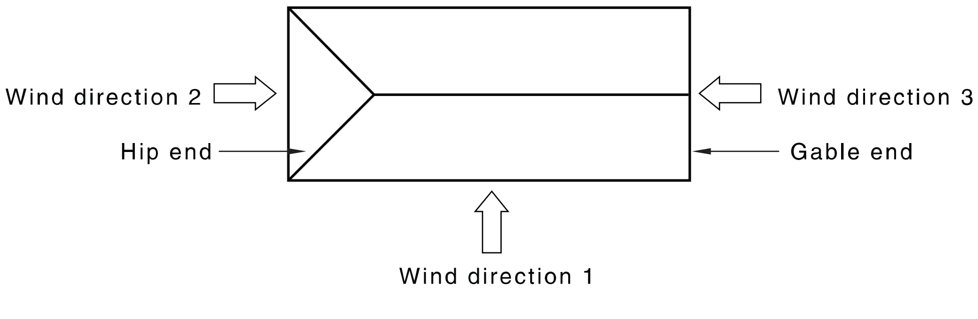
(c) Wind direction 2

NOTE 1 h_0 = half the height of the wall (half the floor to ceiling height).

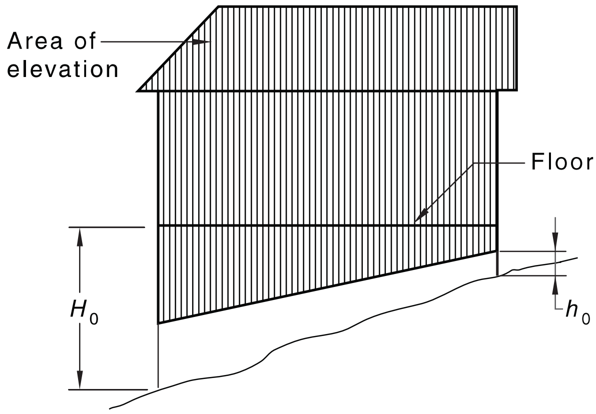
NOTE 2 For houses on sloping ground, the area of elevation will vary depending upon the wind direction or elevation being considered. The racking force calculated for the worst case should be selected.

NOTE 3 The area of elevation of the triangular portion of eaves overhang up to 1 000 mm wide may be ignored in the determination of area of elevation.

Figure 5.2(B) — Determining area of elevation for a two storey or split level building

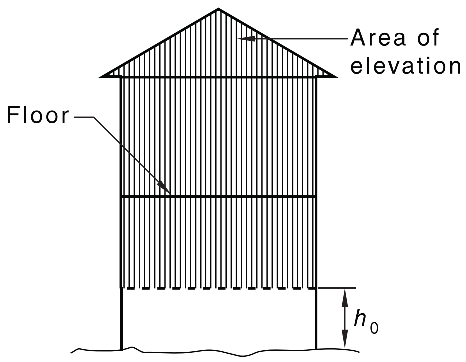


(a) Plan

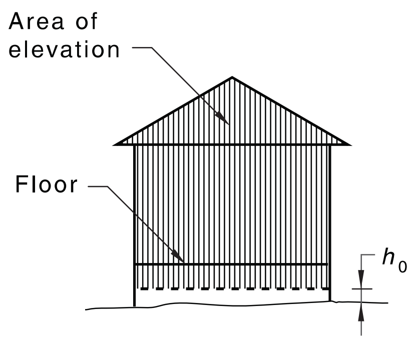


In the subfloor of a two-storey construction, the maximum distance (H_0) from the ground to the underside of the bearer in the lower floor shall be 1 800 mm.

(b) Wind direction 1



(c) Wind direction 2 — Hip end



(d) Wind direction 3 — Gable end

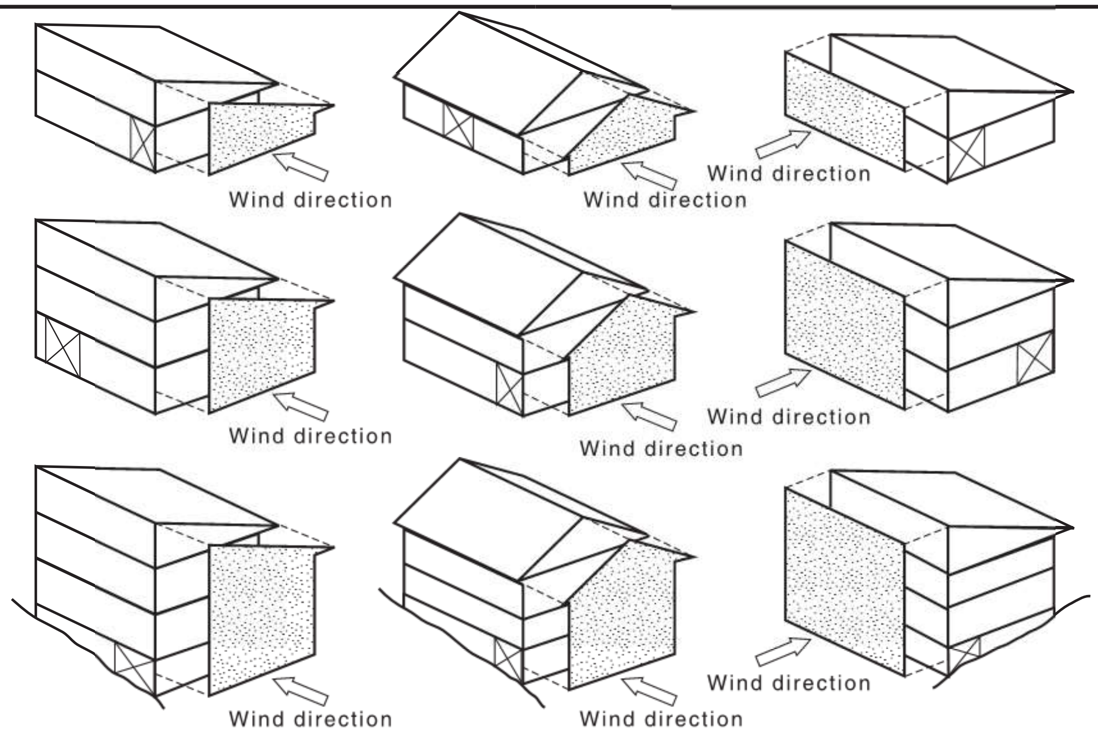
NOTE 1 h_0 = half the height from the ground to the lower-storey floor.

NOTE 2 For wind direction 2, the pressure on the gable end is determined from Table 5.2(A) and the pressure on the hip section of the elevation is determined from Tables 5.2(B) to 5.2(M). The total of racking forces is the sum of the forces calculated for each section.

NOTE 3 The area of elevation of the triangular portion of eaves overhang up to 1 000 mm wide may be ignored in the determination of area of elevation.

Figure 5.2(C) — Determining area of elevation for subfloors

Table 5.2(A) — Vertical surfaces (flat walls, gable ends and skillion ends) — Pressure on area of elevation



Wind class	Pressure kPa
N1	0.66
N2	0.92
N3	1.44
N4	2.14
N5	3.16
N6	4.26
C1	1.44
C2	2.14
C3	3.16
C4	4.26

Table 5.2(B) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Single storey or upper floor of two storeys

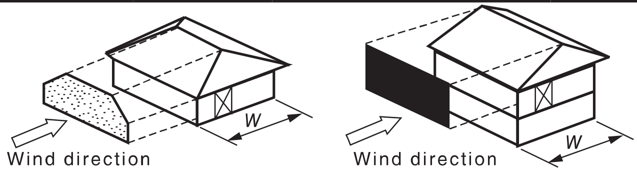
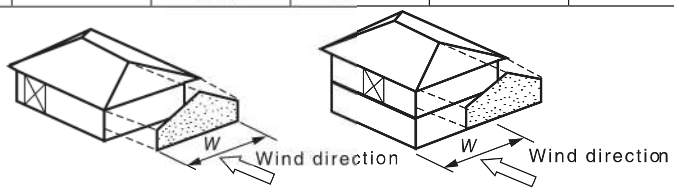
Single storey or upper floor of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	**Roof pitch (degrees)**							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
								
N1: Wind on side								
4	0.58	0.51	0.46	0.43	0.47	0.53	0.53	0.54
5	0.58	0.49	0.44	0.42	0.47	0.53	0.52	0.54
6	0.58	0.48	0.41	0.42	0.48	0.53	0.52	0.55
7	0.58	0.46	0.39	0.42	0.48	0.53	0.52	0.55
8	0.58	0.45	0.37	0.42	0.48	0.53	0.52	0.55
9	0.58	0.44	0.35	0.42	0.49	0.53	0.52	0.55
10	0.58	0.43	0.33	0.41	0.49	0.53	0.52	0.55
11	0.58	0.41	0.32	0.41	0.48	0.53	0.52	0.55
12	0.58	0.40	0.31	0.40	0.48	0.52	0.52	0.55
13	0.58	0.39	0.30	0.39	0.48	0.52	0.51	0.55
14	0.58	0.38	0.29	0.39	0.47	0.52	0.51	0.55
15	0.58	0.38	0.28	0.38	0.47	0.52	0.51	0.55
16	0.58	0.37	0.27	0.38	0.47	0.51	0.51	0.55
								
N1: Wind on end								
4	0.63	0.59	0.56	0.54	0.55	0.57	0.56	0.57
5	0.63	0.58	0.54	0.52	0.55	0.57	0.56	0.57
6	0.63	0.57	0.52	0.52	0.55	0.56	0.55	0.57
7	0.63	0.56	0.51	0.51	0.55	0.56	0.55	0.57
8	0.63	0.55	0.49	0.51	0.55	0.56	0.55	0.57
9	0.63	0.54	0.48	0.51	0.55	0.56	0.55	0.57
10	0.63	0.54	0.46	0.50	0.54	0.56	0.55	0.57
11	0.63	0.53	0.45	0.49	0.54	0.55	0.54	0.57
12	0.63	0.52	0.44	0.49	0.53	0.55	0.54	0.57
13	0.63	0.51	0.43	0.48	0.53	0.55	0.54	0.56
14	0.63	0.50	0.42	0.47	0.52	0.54	0.53	0.56
15	0.63	0.50	0.41	0.47	0.52	0.54	0.53	0.56
16	0.63	0.49	0.40	0.46	0.52	0.54	0.53	0.56

Table 5.2(C) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Lower storey of two storeys

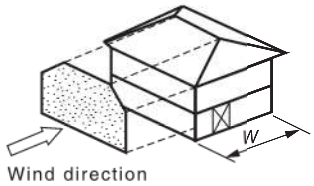
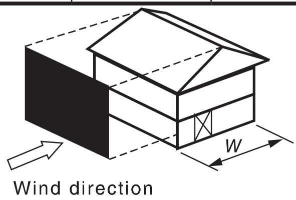
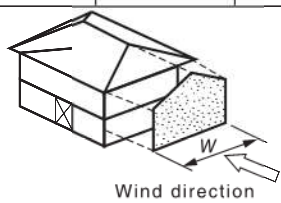
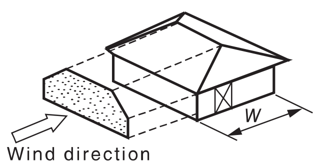
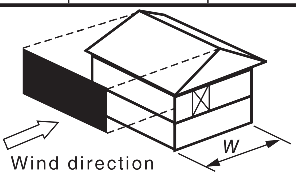
Lower storey of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	**Roof pitch (degrees)**							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
 								
N1: Wind on side								
4	0.58	0.56	0.54	0.52	0.51	0.57	0.59	0.58
5	0.58	0.55	0.53	0.50	0.50	0.56	0.58	0.57
6	0.58	0.54	0.52	0.49	0.50	0.56	0.57	0.57
7	0.58	0.54	0.51	0.48	0.50	0.56	0.56	0.56
8	0.58	0.53	0.50	0.48	0.50	0.56	0.56	0.56
9	0.58	0.53	0.49	0.47	0.50	0.55	0.55	0.56
10	0.58	0.52	0.48	0.46	0.50	0.55	0.54	0.56
11	0.58	0.52	0.47	0.46	0.50	0.55	0.54	0.56
12	0.58	0.51	0.46	0.46	0.50	0.55	0.54	0.56
13	0.58	0.51	0.46	0.46	0.50	0.55	0.54	0.56
14	0.58	0.50	0.45	0.45	0.50	0.55	0.54	0.56
15	0.58	0.50	0.44	0.45	0.50	0.55	0.54	0.56
16	0.58	0.49	0.43	0.45	0.50	0.55	0.54	0.56
								
N1: Wind on end								
4	0.63	0.62	0.61	0.60	0.59	0.60	0.61	0.60
5	0.63	0.62	0.60	0.59	0.58	0.59	0.60	0.59
6	0.63	0.61	0.60	0.58	0.58	0.59	0.60	0.59
7	0.63	0.61	0.59	0.57	0.58	0.59	0.59	0.59
8	0.63	0.61	0.59	0.57	0.58	0.59	0.59	0.59
9	0.63	0.60	0.58	0.56	0.57	0.59	0.58	0.59
10	0.63	0.60	0.57	0.56	0.57	0.58	0.58	0.58
11	0.63	0.60	0.57	0.55	0.57	0.58	0.57	0.58
12	0.63	0.59	0.56	0.55	0.57	0.58	0.57	0.58
13	0.63	0.59	0.56	0.55	0.57	0.58	0.57	0.58
14	0.63	0.59	0.55	0.55	0.57	0.58	0.57	0.58
15	0.63	0.58	0.54	0.55	0.57	0.58	0.57	0.58
16	0.63	0.58	0.54	0.54	0.57	0.58	0.57	0.58

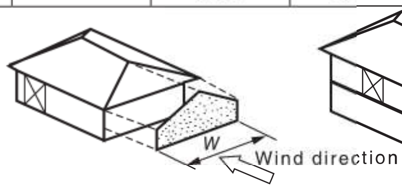
Table 5.2(D) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Single storey or upper floor of two storeys

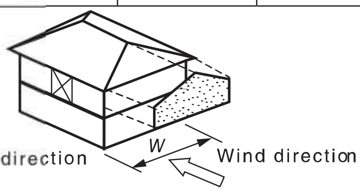
Single storey or upper floor of two storeys — 2.4 m storey, 0.3 m floor





Width (m)	Roof pitch (degrees)							
	0	5	10	15	20	25	30	35
N2: Wind on side								
4	0.81	0.71	0.64	0.60	0.65	0.74	0.74	0.76
5	0.81	0.68	0.61	0.58	0.66	0.74	0.73	0.76
6	0.81	0.66	0.58	0.58	0.66	0.74	0.73	0.76
7	0.81	0.65	0.54	0.58	0.67	0.74	0.73	0.77
8	0.81	0.63	0.52	0.58	0.67	0.74	0.73	0.77
9	0.81	0.61	0.49	0.58	0.68	0.74	0.73	0.77
10	0.81	0.59	0.47	0.58	0.68	0.74	0.73	0.77
11	0.81	0.58	0.45	0.57	0.67	0.73	0.72	0.77
12	0.81	0.56	0.43	0.56	0.67	0.73	0.72	0.77
13	0.81	0.55	0.41	0.55	0.66	0.73	0.72	0.77
14	0.81	0.54	0.40	0.54	0.66	0.72	0.71	0.76
15	0.81	0.52	0.39	0.53	0.66	0.72	0.71	0.76
16	0.81	0.51	0.37	0.53	0.65	0.72	0.71	0.76

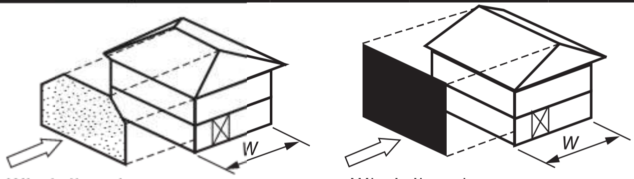




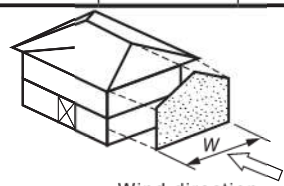
N2: Wind on end								
4	0.88	0.82	0.78	0.75	0.77	0.79	0.79	0.80
5	0.88	0.81	0.76	0.73	0.77	0.79	0.77	0.79
6	0.88	0.80	0.73	0.72	0.76	0.79	0.77	0.79
7	0.88	0.78	0.71	0.72	0.76	0.78	0.77	0.80
8	0.88	0.77	0.69	0.71	0.76	0.78	0.77	0.80
9	0.88	0.76	0.66	0.71	0.76	0.78	0.77	0.80
10	0.88	0.75	0.65	0.70	0.76	0.77	0.76	0.80
11	0.88	0.74	0.63	0.69	0.75	0.77	0.76	0.79
12	0.88	0.72	0.61	0.68	0.74	0.76	0.75	0.79
13	0.88	0.71	0.60	0.67	0.74	0.76	0.75	0.79
14	0.88	0.70	0.58	0.66	0.73	0.76	0.74	0.78
15	0.88	0.69	0.57	0.65	0.73	0.75	0.74	0.78
16	0.88	0.68	0.56	0.64	0.72	0.75	0.74	0.78

Table 5.2(E) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Lower storey of two storeys

Lower storey of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	Roof pitch (degrees)							
	0	5	10	15	20	25	30	35



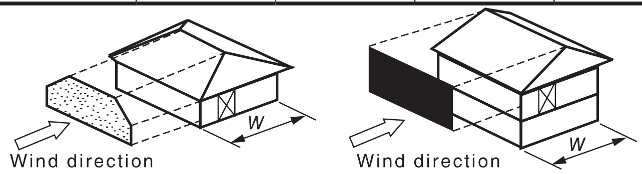
N2: Wind on side								
4	0.81	0.77	0.75	0.72	0.72	0.80	0.82	0.81
5	0.81	0.77	0.73	0.70	0.70	0.78	0.80	0.79
6	0.81	0.76	0.72	0.69	0.70	0.78	0.79	0.79
7	0.81	0.75	0.71	0.67	0.69	0.78	0.78	0.79
8	0.81	0.74	0.70	0.66	0.69	0.77	0.77	0.78
9	0.81	0.74	0.69	0.65	0.69	0.77	0.77	0.78
10	0.81	0.73	0.67	0.64	0.69	0.77	0.76	0.78
11	0.81	0.72	0.66	0.64	0.69	0.77	0.76	0.78
12	0.81	0.71	0.65	0.64	0.69	0.77	0.76	0.78
13	0.81	0.71	0.64	0.63	0.69	0.77	0.75	0.78
14	0.81	0.70	0.62	0.63	0.70	0.77	0.75	0.78
15	0.81	0.69	0.61	0.63	0.70	0.77	0.75	0.78
16	0.81	0.69	0.60	0.63	0.70	0.77	0.75	0.78



N2: Wind on end								
4	0.88	0.86	0.85	0.83	0.83	0.84	0.85	0.84
5	0.88	0.86	0.84	0.82	0.81	0.83	0.84	0.83
6	0.88	0.85	0.83	0.81	0.81	0.82	0.83	0.83
7	0.88	0.85	0.82	0.80	0.81	0.82	0.82	0.82
8	0.88	0.85	0.82	0.79	0.80	0.82	0.82	0.82
9	0.88	0.84	0.81	0.78	0.80	0.82	0.81	0.82
10	0.88	0.84	0.80	0.78	0.80	0.81	0.80	0.81
11	0.88	0.83	0.79	0.77	0.80	0.81	0.80	0.81
12	0.88	0.83	0.78	0.77	0.80	0.81	0.80	0.81
13	0.88	0.82	0.78	0.77	0.80	0.81	0.80	0.81
14	0.88	0.82	0.77	0.76	0.79	0.81	0.80	0.81
15	0.88	0.81	0.76	0.76	0.79	0.81	0.79	0.81
16	0.88	0.81	0.75	0.76	0.79	0.81	0.79	0.81

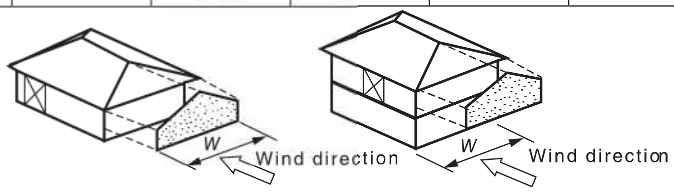
Table 5.2(F) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Single storey or upper floor of two storeys

Single storey or upper floor of two storeys — 2.4 m storey, 0.3 m floor



N3, C1: Wind on side

Width (m)	Roof pitch (degrees)							
	0	5	10	15	20	25	30	35
4	1.27	1.11	1.01	0.94	1.02	1.16	1.16	1.18
5	1.27	1.07	0.96	0.91	1.03	1.16	1.14	1.18
6	1.27	1.04	0.90	0.91	1.04	1.16	1.14	1.19
7	1.27	1.01	0.85	0.91	1.05	1.16	1.14	1.20
8	1.27	0.98	0.81	0.91	1.05	1.16	1.14	1.20
9	1.27	0.95	0.77	0.91	1.06	1.16	1.14	1.21
10	1.27	0.93	0.73	0.90	1.06	1.15	1.14	1.21
11	1.27	0.90	0.70	0.89	1.05	1.15	1.13	1.21
12	1.27	0.88	0.67	0.87	1.04	1.14	1.13	1.20
13	1.27	0.86	0.65	0.86	1.04	1.13	1.12	1.20
14	1.27	0.84	0.62	0.85	1.03	1.13	1.12	1.20
15	1.27	0.82	0.60	0.83	1.03	1.13	1.11	1.19
16	1.27	0.80	0.58	0.82	1.02	1.12	1.11	1.19

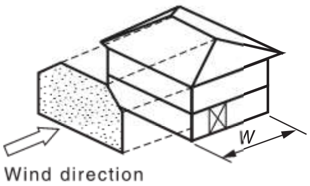


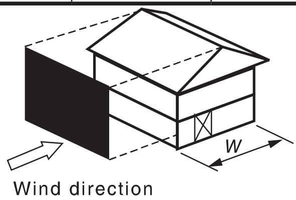
N3, C1: Wind on end

Width (m)	0	5	10	15	20	25	30	35
4	1.38	1.29	1.22	1.17	1.21	1.24	1.23	1.25
5	1.38	1.27	1.18	1.14	1.20	1.23	1.21	1.24
6	1.38	1.25	1.15	1.13	1.20	1.23	1.21	1.24
7	1.38	1.23	1.11	1.12	1.19	1.23	1.20	1.24
8	1.38	1.21	1.07	1.11	1.19	1.22	1.20	1.25
9	1.38	1.19	1.04	1.11	1.19	1.22	1.20	1.25
10	1.38	1.17	1.01	1.09	1.18	1.21	1.19	1.25
11	1.38	1.15	0.98	1.08	1.17	1.20	1.19	1.24
12	1.38	1.13	0.96	1.06	1.16	1.20	1.18	1.24
13	1.38	1.12	0.94	1.04	1.15	1.19	1.17	1.23
14	1.38	1.10	0.91	1.03	1.15	1.18	1.17	1.23
15	1.38	1.09	0.89	1.01	1.14	1.18	1.16	1.22
16	1.38	1.07	0.87	1.00	1.13	1.17	1.15	1.22

Table 5.2(G) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Lower storey of two storeys

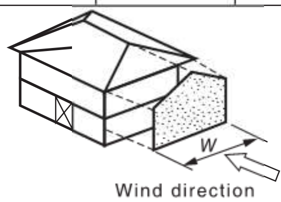
Lower storey of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	**Roof pitch (degrees)**							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**





N3, C1: Wind on side

Width (m)	0	5	10	15	20	25	30	35
4	1.27	1.21	1.17	1.13	1.12	1.25	1.28	1.26
5	1.27	1.20	1.15	1.10	1.09	1.22	1.26	1.24
6	1.27	1.19	1.13	1.08	1.09	1.22	1.24	1.23
7	1.27	1.17	1.11	1.06	1.09	1.22	1.23	1.23
8	1.27	1.16	1.09	1.04	1.08	1.21	1.21	1.22
9	1.27	1.15	1.07	1.02	1.08	1.21	1.20	1.22
10	1.27	1.14	1.05	1.00	1.08	1.21	1.19	1.22
11	1.27	1.13	1.03	1.00	1.08	1.21	1.18	1.22
12	1.27	1.12	1.01	0.99	1.09	1.20	1.18	1.22
13	1.27	1.11	0.99	0.99	1.09	1.20	1.18	1.22
14	1.27	1.10	0.98	0.99	1.09	1.20	1.18	1.22
15	1.27	1.08	0.96	0.99	1.09	1.20	1.18	1.23
16	1.27	1.07	0.94	0.99	1.09	1.20	1.18	1.23



N3, C1: Wind on end

Width (m)	0	5	10	15	20	25	30	35
4	1.38	1.35	1.33	1.30	1.29	1.31	1.32	1.31
5	1.38	1.34	1.31	1.28	1.27	1.29	1.31	1.30
6	1.38	1.34	1.30	1.27	1.27	1.29	1.30	1.29
7	1.38	1.33	1.29	1.25	1.26	1.28	1.29	1.29
8	1.38	1.32	1.28	1.24	1.26	1.28	1.28	1.28
9	1.38	1.32	1.27	1.23	1.25	1.28	1.27	1.28
10	1.38	1.31	1.25	1.21	1.25	1.28	1.26	1.27
11	1.38	1.30	1.24	1.21	1.25	1.27	1.25	1.27
12	1.38	1.30	1.23	1.20	1.25	1.27	1.25	1.27
13	1.38	1.29	1.21	1.20	1.24	1.27	1.25	1.27
14	1.38	1.28	1.20	1.20	1.24	1.26	1.25	1.27
15	1.38	1.28	1.19	1.19	1.24	1.26	1.24	1.27
16	1.38	1.27	1.18	1.19	1.24	1.26	1.24	1.27

Table 5.2(H) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Single storey or upper floor of two storeys

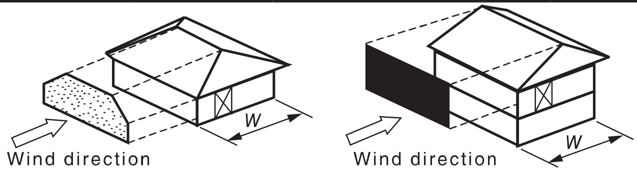
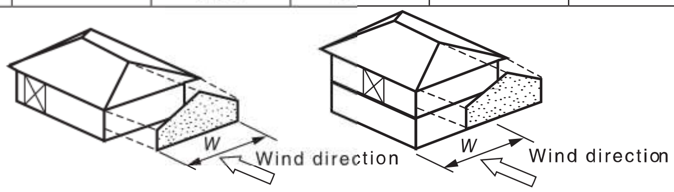
Single storey or upper floor of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	**Roof pitch (degrees)**							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
								
N4, C2: Wind on side								
4	1.88	1.64	1.49	1.40	1.52	1.72	1.72	1.76
5	1.88	1.59	1.42	1.35	1.53	1.72	1.69	1.76
6	1.88	1.55	1.34	1.35	1.54	1.72	1.69	1.77
7	1.88	1.50	1.27	1.35	1.55	1.72	1.69	1.78
8	1.88	1.46	1.20	1.35	1.56	1.72	1.69	1.79
9	1.88	1.42	1.14	1.35	1.57	1.72	1.70	1.80
10	1.88	1.38	1.09	1.34	1.57	1.72	1.69	1.80
11	1.88	1.34	1.04	1.32	1.56	1.70	1.68	1.79
12	1.88	1.31	1.00	1.30	1.55	1.69	1.67	1.79
13	1.88	1.28	0.96	1.28	1.54	1.69	1.67	1.78
14	1.88	1.25	0.93	1.26	1.53	1.68	1.66	1.78
15	1.88	1.22	0.90	1.24	1.53	1.67	1.65	1.78
16	1.88	1.19	0.87	1.22	1.52	1.67	1.65	1.77
								
N4, C2: Wind on end								
4	2.05	1.91	1.81	1.74	1.79	1.84	1.83	1.85
5	2.05	1.88	1.76	1.69	1.78	1.83	1.80	1.84
6	2.05	1.85	1.70	1.68	1.78	1.83	1.80	1.85
7	2.05	1.82	1.65	1.66	1.77	1.82	1.79	1.85
8	2.05	1.79	1.60	1.65	1.77	1.81	1.79	1.85
9	2.05	1.76	1.55	1.64	1.77	1.81	1.78	1.85
10	2.05	1.74	1.50	1.63	1.76	1.80	1.77	1.85
11	2.05	1.71	1.46	1.60	1.74	1.79	1.76	1.84
12	2.05	1.69	1.43	1.57	1.73	1.78	1.75	1.84
13	2.05	1.66	1.39	1.55	1.71	1.77	1.74	1.83
14	2.05	1.64	1.36	1.53	1.70	1.76	1.73	1.82
15	2.05	1.61	1.32	1.51	1.69	1.75	1.72	1.82
16	2.05	1.59	1.29	1.49	1.68	1.74	1.72	1.81

Table 5.2(I) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Lower storey of two storeys

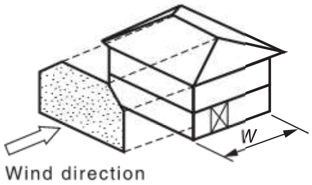
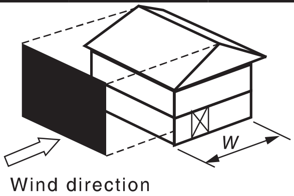
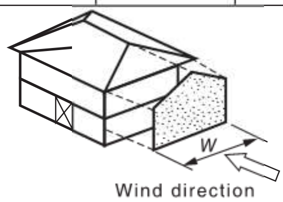
Lower storey of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	**Roof pitch (degrees)**							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
 								
N4, C2: Wind on side								
4	1.88	1.80	1.74	1.68	1.67	1.86	1.90	1.87
5	1.88	1.78	1.71	1.63	1.62	1.82	1.87	1.84
6	1.88	1.76	1.68	1.60	1.62	1.81	1.84	1.83
7	1.88	1.75	1.65	1.57	1.61	1.81	1.82	1.83
8	1.88	1.73	1.62	1.54	1.61	1.80	1.80	1.82
9	1.88	1.71	1.59	1.51	1.61	1.80	1.78	1.81
10	1.88	1.69	1.57	1.49	1.61	1.80	1.76	1.81
11	1.88	1.68	1.54	1.48	1.61	1.79	1.76	1.81
12	1.88	1.66	1.51	1.48	1.61	1.79	1.76	1.81
13	1.88	1.64	1.48	1.48	1.62	1.79	1.75	1.82
14	1.88	1.63	1.45	1.47	1.62	1.78	1.75	1.82
15	1.88	1.61	1.42	1.47	1.62	1.78	1.75	1.82
16	1.88	1.60	1.40	1.47	1.62	1.78	1.75	1.82
								
N4, C2: Wind on end								
4	2.05	2.01	1.97	1.93	1.92	1.94	1.97	1.95
5	2.05	2.00	1.95	1.91	1.89	1.92	1.95	1.93
6	2.05	1.99	1.93	1.88	1.88	1.91	1.93	1.92
7	2.05	1.98	1.92	1.86	1.88	1.91	1.91	1.91
8	2.05	1.97	1.90	1.84	1.87	1.90	1.90	1.91
9	2.05	1.96	1.88	1.82	1.86	1.90	1.88	1.90
10	2.05	1.95	1.86	1.80	1.86	1.90	1.87	1.89
11	2.05	1.94	1.84	1.79	1.85	1.89	1.86	1.89
12	2.05	1.92	1.82	1.79	1.85	1.89	1.86	1.89
13	2.05	1.91	1.80	1.78	1.85	1.88	1.86	1.89
14	2.05	1.90	1.78	1.78	1.85	1.88	1.85	1.89
15	2.05	1.89	1.77	1.77	1.84	1.88	1.85	1.89
16	2.05	1.89	1.75	1.77	1.84	1.87	1.85	1.89

Table 5.2(J) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Single storey or upper floor of two storeys

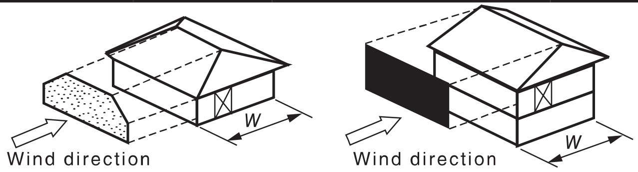
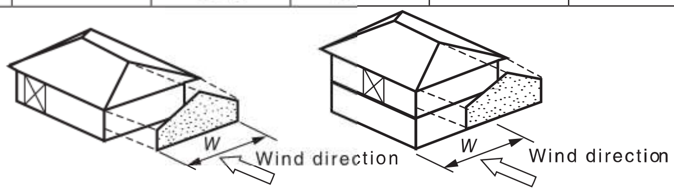
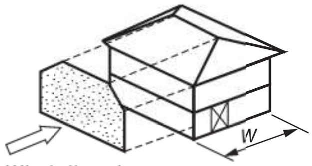
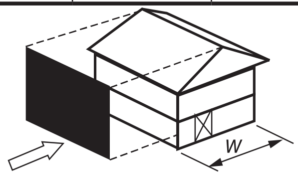
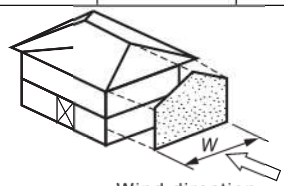
Single storey or upper floor of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	**Roof pitch (degrees)**							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
								
N5, C3: Wind on side								
4	2.78	2.43	2.21	2.06	2.25	2.55	2.54	2.60
5	2.78	2.35	2.10	1.99	2.25	2.55	2.49	2.60
6	2.78	2.28	1.98	1.99	2.27	2.54	2.50	2.62
7	2.78	2.22	1.87	1.99	2.29	2.54	2.50	2.63
8	2.78	2.15	1.77	1.99	2.31	2.54	2.50	2.64
9	2.78	2.09	1.68	2.00	2.32	2.54	2.50	2.66
10	2.78	2.04	1.60	1.98	2.32	2.53	2.50	2.66
11	2.78	1.98	1.54	1.94	2.31	2.52	2.48	2.65
12	2.78	1.93	1.48	1.91	2.29	2.50	2.47	2.64
13	2.78	1.89	1.42	1.88	2.28	2.49	2.46	2.63
14	2.78	1.84	1.37	1.86	2.27	2.48	2.45	2.63
15	2.78	1.80	1.32	1.83	2.25	2.47	2.44	2.62
16	2.78	1.76	1.28	1.81	2.24	2.46	2.43	2.62
								
N5, C3: Wind on end								
4	3.03	2.83	2.68	2.56	2.65	2.72	2.71	2.74
5	3.03	2.78	2.60	2.50	2.63	2.71	2.66	2.72
6	3.03	2.73	2.51	2.48	2.62	2.70	2.65	2.73
7	3.03	2.69	2.43	2.46	2.62	2.69	2.64	2.73
8	3.03	2.65	2.36	2.44	2.61	2.68	2.64	2.73
9	3.03	2.61	2.28	2.42	2.61	2.67	2.63	2.74
10	3.03	2.57	2.22	2.40	2.60	2.66	2.62	2.73
11	3.03	2.53	2.16	2.36	2.57	2.64	2.60	2.72
12	3.03	2.49	2.11	2.32	2.55	2.63	2.59	2.71
13	3.03	2.45	2.05	2.29	2.53	2.61	2.57	2.70
14	3.03	2.42	2.00	2.26	2.51	2.60	2.56	2.69
15	3.03	2.38	1.96	2.23	2.50	2.58	2.55	2.69
16	3.03	2.35	1.91	2.20	2.48	2.57	2.53	2.68

Table 5.2(K) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Lower storey of two storeys





Lower storey of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	Roof pitch (degrees)							
	0	5	10	15	20	25	30	35
N5, C3: Wind on side								
4	2.78	2.66	2.57	2.48	2.46	2.74	2.80	2.77
5	2.78	2.63	2.52	2.41	2.40	2.68	2.76	2.72
6	2.78	2.61	2.48	2.36	2.39	2.67	2.72	2.71
7	2.78	2.58	2.44	2.32	2.38	2.67	2.69	2.70
8	2.78	2.55	2.39	2.28	2.38	2.66	2.66	2.69
9	2.78	2.53	2.35	2.24	2.38	2.66	2.63	2.68
10	2.78	2.50	2.31	2.20	2.37	2.65	2.60	2.67
11	2.78	2.48	2.27	2.19	2.38	2.65	2.60	2.68
12	2.78	2.45	2.23	2.18	2.38	2.64	2.59	2.68
13	2.78	2.43	2.18	2.18	2.39	2.64	2.59	2.68
14	2.78	2.40	2.14	2.18	2.39	2.64	2.59	2.69
15	2.78	2.38	2.10	2.17	2.39	2.63	2.59	2.69
16	2.78	2.36	2.06	2.17	2.40	2.63	2.58	2.69



N5, C3: Wind on end								
4	3.03	2.97	2.91	2.85	2.84	2.87	2.90	2.88
5	3.03	2.95	2.88	2.81	2.80	2.84	2.88	2.85
6	3.03	2.93	2.86	2.78	2.78	2.83	2.85	2.84
7	3.03	2.92	2.83	2.75	2.77	2.82	2.83	2.82
8	3.03	2.90	2.80	2.72	2.76	2.81	2.80	2.81
9	3.03	2.89	2.78	2.69	2.75	2.80	2.78	2.81
10	3.03	2.87	2.75	2.66	2.74	2.80	2.76	2.80
11	3.03	2.86	2.72	2.65	2.74	2.79	2.75	2.80
12	3.03	2.84	2.69	2.64	2.73	2.79	2.75	2.79
13	3.03	2.83	2.66	2.63	2.73	2.78	2.74	2.79
14	3.03	2.81	2.63	2.62	2.73	2.78	2.74	2.79
15	3.03	2.80	2.61	2.62	2.72	2.77	2.73	2.79
16	3.03	2.78	2.58	2.61	2.72	2.77	2.73	2.79

Table 5.2(L) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Single storey or upper floor of two storeys

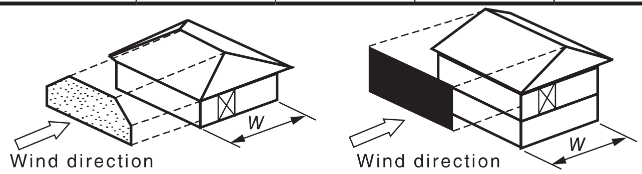
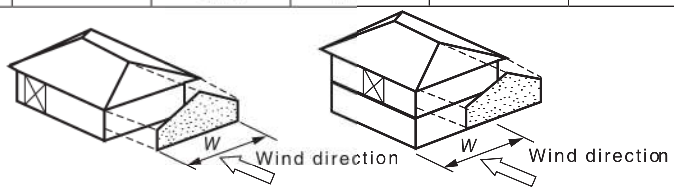
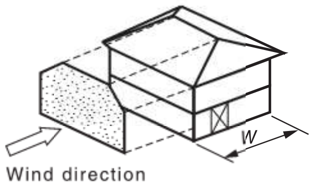
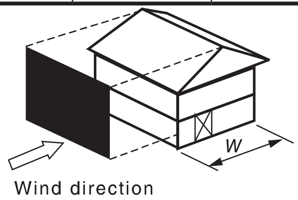
Single storey or upper floor of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	**Roof pitch (degrees)**							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**
								
N6, C4: Wind on side								
4	3.75	3.27	2.97	2.78	3.03	3.43	3.42	3.50
5	3.75	3.17	2.83	2.68	3.04	3.43	3.36	3.50
6	3.75	3.08	2.66	2.68	3.07	3.43	3.36	3.53
7	3.75	2.99	2.52	2.69	3.09	3.43	3.37	3.55
8	3.75	2.90	2.39	2.69	3.11	3.43	3.37	3.56
9	3.75	2.82	2.27	2.69	3.13	3.42	3.37	3.58
10	3.75	2.75	2.16	2.67	3.13	3.41	3.37	3.58
11	3.75	2.68	2.07	2.62	3.11	3.39	3.35	3.57
12	3.75	2.61	1.99	2.58	3.09	3.37	3.33	3.56
13	3.75	2.54	1.92	2.54	3.07	3.36	3.31	3.55
14	3.75	2.48	1.85	2.50	3.05	3.34	3.30	3.54
15	3.75	2.42	1.78	2.47	3.04	3.33	3.29	3.53
16	3.75	2.37	1.72	2.44	3.02	3.32	3.28	3.53
								
N6, C4: Wind on end								
4	4.09	3.81	3.61	3.46	3.57	3.67	3.65	3.69
5	4.09	3.75	3.50	3.36	3.54	3.65	3.59	3.67
6	4.09	3.69	3.39	3.34	3.54	3.64	3.58	3.68
7	4.09	3.63	3.28	3.31	3.53	3.62	3.56	3.68
8	4.09	3.57	3.18	3.29	3.52	3.61	3.55	3.69
9	4.09	3.51	3.08	3.27	3.52	3.60	3.55	3.69
10	4.09	3.46	2.99	3.23	3.50	3.59	3.53	3.69
11	4.09	3.41	2.91	3.18	3.47	3.56	3.51	3.67
12	4.09	3.36	2.84	3.13	3.44	3.54	3.49	3.66
13	4.09	3.31	2.77	3.09	3.41	3.52	3.47	3.64
14	4.09	3.26	2.70	3.04	3.39	3.50	3.45	3.63
15	4.09	3.21	2.64	3.00	3.36	3.48	3.43	3.62
16	4.09	3.17	2.58	2.96	3.34	3.47	3.42	3.61

Table 5.2(M) — Hip roofs and side wind on gable roofs — Pressure (kPa) on area of elevation — Lower storey of two storeys

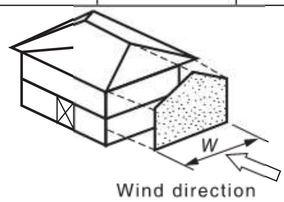
Lower storey of two storeys — 2.4 m storey, 0.3 m floor								
Width (m)	**Roof pitch (degrees)**							
	0	**5**	**10**	**15**	**20**	**25**	**30**	**35**





N6, C4: Wind on side

Width (m)	0	5	10	15	20	25	30	35
4	3.75	3.59	3.47	3.34	3.32	3.69	3.78	3.73
5	3.75	3.55	3.40	3.25	3.23	3.62	3.72	3.67
6	3.75	3.51	3.34	3.18	3.22	3.60	3.67	3.65
7	3.75	3.48	3.28	3.12	3.21	3.60	3.62	3.63
8	3.75	3.44	3.23	3.07	3.21	3.59	3.58	3.62
9	3.75	3.41	3.17	3.01	3.20	3.58	3.54	3.61
10	3.75	3.37	3.12	2.96	3.20	3.57	3.51	3.60
11	3.75	3.34	3.06	2.95	3.20	3.57	3.50	3.61
12	3.75	3.30	3.00	2.94	3.21	3.56	3.50	3.61
13	3.75	3.27	2.94	2.94	3.22	3.56	3.49	3.62
14	3.75	3.24	2.89	2.93	3.22	3.55	3.49	3.62
15	3.75	3.21	2.83	2.93	3.23	3.55	3.49	3.63
16	3.75	3.18	2.78	2.92	3.23	3.54	3.48	3.63



N6, C4: Wind on end

Width (m)	0	5	10	15	20	25	30	35
4	4.09	4.00	3.93	3.85	3.83	3.87	3.91	3.88
5	4.09	3.98	3.89	3.79	3.77	3.82	3.88	3.84
6	4.09	3.96	3.85	3.75	3.75	3.81	3.84	3.82
7	4.09	3.94	3.81	3.71	3.74	3.80	3.81	3.81
8	4.09	3.91	3.78	3.67	3.72	3.79	3.78	3.79
9	4.09	3.89	3.74	3.63	3.71	3.78	3.75	3.78
10	4.09	3.87	3.71	3.59	3.70	3.77	3.72	3.77
11	4.09	3.85	3.67	3.57	3.69	3.76	3.71	3.77
12	4.09	3.83	3.63	3.56	3.69	3.76	3.70	3.77
13	4.09	3.81	3.59	3.55	3.68	3.75	3.69	3.77
14	4.09	3.79	3.55	3.54	3.68	3.74	3.69	3.77
15	4.09	3.77	3.51	3.53	3.67	3.74	3.68	3.77
16	4.09	3.75	3.48	3.51	3.67	3.73	3.67	3.77

Appendix A
(informative)

Commentary

A.1 General

This appendix provides commentary on the text in this document.

A.2 Section 1

A.2.1 Clause 1.1 — Scope

This document has been derived for houses as a group or large numbers of buildings. In general, the level of reliability for the group is similar to that found by applying AS/NZS 1170.2. However, it is recognized that a correct application of this document may lead to some houses with more conservative design loads and others with less conservative design loads.

It is important to categorize each building on a case-by-case basis. Each site should be assessed individually for its wind classification. Each building should be assessed for conformance with geometry and for evaluation of pressures.

A.2.2 Clause 1.2 — Geometric limits

The geometric limits presented in Clause 1.2 have been provided to enable some simplifications to the AS/NZS 1170.2 methods for the most common geometries of housing. These limitations are necessary to balance the simplifications made in AS 4055. The limitations are given to 0.1 m which indicates the tolerances on the dimensions.

It is intended that 16.0 m width limit be applied to the width of the tallest section of the house. For example, in many cases the various sections of a house (that is the basic rectangular box shapes) may be displaced horizontally with respect to each other. This could make the overall floor plan dimension greater than the 16.0 m limit even though none of the sections of roof may be wider than 16.0 m.

Such a house should be within the limits provided that none of the roof sections parallel to the wind direction being considered are greater than 16.0 m neglecting the width of eaves up to a maximum of 900 mm per eaves. Where eaves are wider than 900 mm, it is only 900mm of eaves that can be neglected in calculating the width of the house.

The reference for roof height and eaves height measurements is the averaged ground level through the site. For sites with retaining walls, the averaged ground level is to be taken as the lines through the mid-heights of the retaining walls. The height to the eaves may be taken at the edge that normally would have a gutter.

If any of the geometric limitations cannot be met, then the house falls outside the scope of AS 4055 and design wind actions should be evaluated using AS/NZS 1170.2. The geometric limitations given in the AS 1684 series are similar to the limits in AS 4055, but not identical. They are generally consistent with the AS 4055 limits but are intended to enable simplified structural behaviour models rather than the simplified wind loading models used in AS 4055.

The main limitations are on the dimensions of the building – height to eaves, height to top of roof and width parallel to the ridge. In many cases, single or two storey houses will satisfy these requirements, but three storey houses may not. It is possible that three storey houses with most of the lower storey in cut may satisfy the geometric limitations and AS 4055 can be used on these houses.

A.2.3 Clause 1.2 — Use of AS/NZS 1170.2

Where houses are outside the geometric limits of AS 4055, designers will have to use AS/NZS 1170.2 to evaluate wind actions. In some cases, it will be necessary to derive an equivalent wind classification for ordering building components. (Note that if the house also falls outside the limits in the relevant light framing standard or handbook, then other Standards must be used to size framing members.)

An equivalent wind classification can be found by the following two methods:

(a) Using AS/NZS 1170.2 to determine $V_{des,\theta}$ for cladding on the building based on a 1/500 probability of exceedance — This will be obtained for four directions, having previously evaluated $V_{sit,\beta}$ for eight directions. The highest value of $V_{des,\theta}$ for cladding can be used in Tables 2.1 (A) or (B) to select a wind classification that has a higher V_u than the highest value of $V_{des,\theta}$.

(b) Using AS/NZS 1170.2 to determine the design wind pressures on the elements being ordered based on a regional wind velocity with a 1/500 probability of exceedance — The tables in Section 3 can be used to obtain an equivalent wind classification for the element being ordered.

A.3 Section 2

A.3.1 Tables 2.1(A) and 2.1(B) — Design gust wind speed

An approximate 50 % increase in wind pressures occurs from one class to the next higher one, that is, N2 to N3, N3 to N4, etc.

Once a particular building site has been classified using the methods set out in Section 2, the ultimate wind speed for that class represents the design wind speed for the house and includes the effects of —

(a) the importance level which is set by the NCC (the design wind loading level associated with housing);

(b) directionality (the likelihood of wind occurring at its maximum from the direction for which the house is most vulnerable in terms of the pressures on the envelope);

(c) height (of the building above the ground);

(d) terrain roughness (sizes of the obstructions in the wider area around the building site such as water, grass, open space and size of buildings);

(e) topography (the position of the site on hills or in valleys); and

(f) shielding (the effect of specific buildings and other obstructions near to the proposed building).

The design gust wind speeds are related to the $V_{des,\theta}$ in AS/NZS 1170.2. They are based on peak gust wind speeds with a gust duration of around 0.2 s. These velocities are higher than the 3 s gusts reported by the Bureau of Meteorology. The use of Bureau data to corroborate the wind speeds obtained from this document should use gust duration correction factors.

A.3.2 Table 2.2 — Site wind classification

In determining the application of the N and C wind classifications to the selected site criteria that are given in Table 2.2, a number of simplifications of the methods in AS/NZS 1170.2 were made. The classifications were derived from a range of design scenarios that were evaluated using AS/NZS 1170.2. The following criteria were selected:

(a) Annual probability of exceedance for the ultimate limit state has been taken as 1/500 and annual probability of exceedance for the serviceability limit state has been taken as 1/25.

(b) For wind Regions A and B, a 0.95 factor on wind speed was allowed to account for the variation of orientation of houses within suburbs and groups of suburbs and the fact that the peak wind gust will only come from a single direction. There will be few for which this direction is the critical one with respect to terrain, topography and the house orientation. For wind Regions C and D, a factor of 1.0 was used consistent with the value for the directionality multiplier for cladding and envelope elements in AS/NZS 1170.2.

(c) AS/NZS 1170.2 now includes a climate change multiplier (M_c), with a current value of 1.05 for cyclonic regions. This factor has been included into wind classification C of this document.

(d) A 5 % margin has been allowed on the wind speed for the assigning of the N and C classes.

(e) Average roof height has been taken as 6.5 m (selected as not the worst case but covering the majority of average housing being constructed within the limitations given in Figure 1.2).

(f) The terrain/height multiplier ($M_{6.5,cat}$) has been derived from AS/NZS 1170.2 with h (average roof height) taken as 6.5 m, see Table A.3.2(A).

(g) Topographic multiplier (M_t) has been derived from the hill shape multiplier defined in AS/NZS 1170.2, see Table A.3.2(B) below. The values chosen for T1 to T5 represent the average of the ranges for each class (T0 is taken as 1.0 to represent housing on flat or nearly flat topography). For the top third, the class changes for slopes greater than 30 m high. A column has also been included for hill heights of less than 10 m to facilitate correct classification of topography on small hills (with a height the same order as the height of houses). The separation zone at the crest has not been included, but for escarpments only, a zone immediately over the crest is included.

Shielding multiplier (M_s) has been derived from AS/NZS 1170.2, see Table A.3.2(C) below.

Table A.3.2(A) — Terrain category multiplier ($M_{6.5,cat}$) at height 6.5 m

Region	Terrain category multiplier ($M_{6.5,cat}$)			
	Terrain Category 1	Terrain Category 2	Terrain Category 2.5	Terrain Category 3
All regions	1.03	0.94	0.88	0.83

Table A.3.2(B) — Topographic multiplier (M_t)

Topographic class	Value of topographic multiplier (M_t) applied in calculation of the N and C categories	Range of values calculated using AS/NZS 1170.2 that are included in the class
T0	1.0	≥ 1 < 1.08
T1	1.1	≥ 1.04 < 1.16
T2	1.2	≥ 1.14 < 1.25
T3	1.3	≥ 1.21 < 1.37
T4	1.42	≥ 1.29 < 1.47
T5	1.57	≥ 1.47

Table A.3.2(C) — Shielding multiplier (M_s)

Shielding class	Shielding multiplier (M_s)
Full shielding (FS)	0.85
Partial shielding (PS)	0.95
No shielding (NS)	1.00

The map in Figure 2.2 is based on the wind regions map in AS/NZS 1170.2. AS 4055 does not make use of sub-regions, so wind Regions A and B are shown without their sub-regions.

A.3.3 Terrain category

The definitions of terrain category in this document are consistent with those in AS/NZS 1170.2.

Terrain Category 2.5 addresses acreage subdivisions where the house density is less than 10 per hectare. This level of roughness is also appropriate for some wooded agricultural land or farms with very high crops such as sugar cane.

Large trees offer some surface roughness. Even if the trees are stripped of leaves (i.e. denuded) in very strong winds, the standing trees contribute to the surface roughness. This is a very different concept to shielding where a denuded tree is not able to offer protection to a nearby structure. The density of trees is important in assigning terrain categories. For a tree to be considered as a 'large tree' it must have an areal extent similar to that of a house, a height greater than that of a house and have relatively dense foliage. In many cases, the height and density of the trees cannot be evaluated from satellite imagery and a site visit will be required to check. Where trees (including clumps of trees) are large and robust (similar size to houses) then wooded areas with —

(a) vegetation classifications in accordance with AS 3959 of Group B Woodland or Group C Shrubland (fewer than 2 large trees per hectare) can be categorized as TC2;

(b) between 2 and 10 large trees per hectare can be categorized as TC2.5; and

(c) vegetation classifications in accordance with AS 3959 of Group A Forest and Group F Rainforest (more than 10 large trees per hectare) can be categorized as TC3.

In some cases, the 500 m radius circle may contain combinations of smooth features. For example, a small lake with diameter less than 200 m may be adjoined by a park also with width less than 200 m. However, the combined width of smooth features is greater than 200 m and the lake should be considered as part of the park, giving limiting terrain category for the building at the centre of the 500 m radius circle as TC2.

Other combinations of smooth features may be less apparent. For example, a freeway reserve of width 150 m may be adjacent to a creek and reserve of width 100 m. Here the total width of smooth features is greater than 200 m and so can be categorized as a region of TC2.

Where the smooth features do not adjoin they do not have to be combined. For example, a freeway reserve of width 150 m and a creek reserve of width 100 m separated by two rows of houses can be treated as two separate smooth features, each with a width of less than 200 m. The two separated features do not affect the terrain category.

The following satellite images show different terrain categories consistent with the definitions and the guidance in this appendix.

In Figures A.3.3(A) to A.3.3(E) the red lines differentiate regions of different terrain categories. Figure A.3.3(A) provides an example of the assessment of the terrain category of an individual site shown by the intersection of the blue lines. It will be the terrain with the lowest TC number within 500 m of the site. In this case, a yellow circle of radius 500 m has been drawn around the site. Although it contains mostly TC3 areas, some TC2 does encroach on the circle. TC2 includes parks, parking, public open spaces and vacant land. The vacant land has been undeveloped for more than 20 years and there are no plans to develop it in the next five years. Although TC2 is less than 200 000 m^2, it is in contact with a large area of the more open TC1 so can be regarded as a very large area of open terrain. This house would be classified as TC2. Different houses in this figure may have different classifications.

[SOURCE: Figure A.3.3.(A) reproduced with permission from Department of Resources, Queensland © State of Queensland 2021.]

Figure A.3.3(A) — Example of coastal terrains

[SOURCE: Figure A.3.3.(B) reproduced with permission from Department of Resources, Queensland © State of Queensland 2021.]

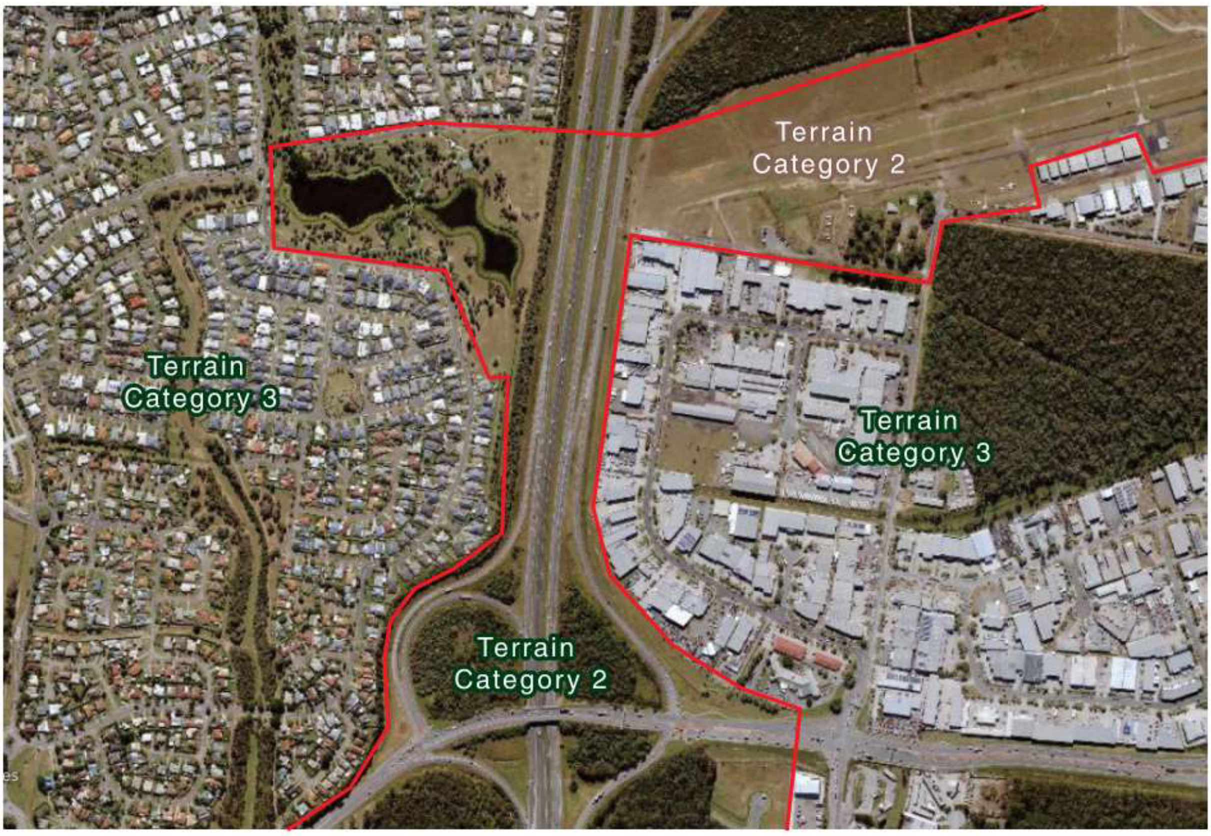
Figure A.3.3(B) — Example of outer urban terrains

[SOURCE: Figure A.3.3.(C) reproduced with permission from Department of Resources, Queensland © State of Queensland 2021.]

Figure A.3.3(C) — Example of the edge of suburban terrains

[SOURCE: Figure A.3.3.(D) reproduced with permission from Department of Resources, Queensland © State of Queensland 2021.]

Figure A.3.3(D) — Example of suburban terrains



[SOURCE: Figure A.3.3.(E) reproduced with permission from Department of Resources, Queensland © State of Queensland 2021.]

Figure A.3.3(E) — Examples of light industrial and suburban terrains with major roads

Appendix C has some examples of the application of terrain classification. It shows that within 500 m of a change in terrain category, the lowest terrain category applies to all housing.

A.3.4 Topographic class

The topographic class in Table A.3.2(B) is derived from the topographic multipliers used in AS/NZS 1170.2. A contour map will be required to evaluate this class.

The evaluation method in this document is quite similar to that in AS/NZS 1170.2. However, AS/NZS 1170.2 requires the calculation of topographic multipliers for 8 wind directions, but in this document only one evaluation is required. This is for the line through the site that has the highest slope in the upper half of the rise. Use the following to determine the relevant line:

(a) Choose the line roughly perpendicular to the contours through the site.

(b) If there are a number of possibilities of choosing a line perpendicular to the contours through the site, choose the line on which the contours are closest together.

Where houses are near the top of the slope, it may be necessary to consider slopes on the other side of the local crest from the site. If they are within *d* of the top of the slope in that direction as shown in Figure 2.4(B), then this slope should also be considered as applying to the site.

If there are a number of different directions that may give similar slopes, the one that gives the highest topographic class should be used.

A.3.5 Shielding

In assessing shielding, permanent obstructions of the same size as the house designed with a frequency of more than 10 per hectare within 100 m of the site, can be considered as providing full shielding. This means that two full rows of housing are required on all sides to give full shielding. If only one full row of housing is available on one side, then the site is categorized as "partially shielded". If there are no shielding obstructions on at least one side, then it is classified as "not shielded".

The effects of roads or other small open areas, in the direction that the wind is blowing, with a width of less than 20 m adjacent to the house site may be ignored. For example, a house that is on a typical suburban street road reserve (e.g. less than 20 m wide including the footpaths and road) can still have full shielding provided there are two rows of houses beyond the opposite side of the street. This includes houses facing minor T-intersections.

In assessing shielding, a reasonable estimate should be made about infill development in the next five years, as it is the anticipated development five years after construction that is assessed.

Consistent with AS/NZS 1170.2, denuded trees can offer surface roughness that contributes to the terrain category classification.

In contrast to AS/NZS 1170.2, this document allows large permanent trees closely spaced over an area larger than suburban blocks to provide shielding for houses in wind Regions A and B. In Clause 2.5, permanent trees are those that are unlikely to be removed in the intended use of the land. Trees are spaced closely enough to offer shielding when they completely obscure the view of the house at the specified depth, i.e. vegetation that fits within the AS 3959 classifications of Group A Forest and Group F Rainforest.

Tropical cyclones can remove enough vegetation from large trees to mean that they cannot be regarded as shielding for houses, so vegetation in wind Regions C and D cannot be regarded as shielding.

A.3.6 Wall and roof wind classifications

Table 2.2 gives a site wind classification. Tables 2.6.1(A) and (B) are used to translate the site wind classification into wall and roof classifications for ordering wall elements such as wall cladding and windows or roof elements such as roofing materials.

Wall elements will be ordered using the w classifications and roof elements using the r classifications. In future versions of AS 4055, there may be some differences in these w and r classifications depending on features of the house itself. For example, in the future, elements on hip roofs may have different r classifications to those on flat or gable roofs. However, in this edition, there is a one-to-one mapping for all of the site, wall and roof wind classifications.

For all houses, roof elements currently classified as Nx or Cx elements may be used directly as Nxr or Cxr elements. For example, roof elements currently classified as suitable for N2 are N2r elements. Likewise for all houses, wall elements currently classified as Nx or Cx elements can be used directly as Nxw or Cxw elements. For example, wall elements currently classified as suitable for N2 are N2w elements.

A.4 Sections 3 and 4 — Calculation of pressures and forces

The pressure coefficients given in Sections 3 and 4 have been based on AS/NZS 1170.2. The following criteria were used:

(a) The house comprises basically rectangular bluff bodies within the geometric shape limits given in Clause 1.2.

(b) Roofs are of normal shape, e.g. not arched.

(c) Net pressure coefficients comprise the addition of internal and external pressures on the building envelope. The combination factor (K_C in AS/NZS 1170.2) is included to take into account peak pressures occurring on different surfaces at slightly different times.

(d) Pressures include the effects of dominant openings for Regions C and D only.

(e) In order to justify the use of lower internal pressures in Regions A and B, all elements of the building envelope, which include cladding, windows and doors, need to be able to withstand the design wind pressures.

(f) Pressures include the effects of local high-pressure zones on the leading edges of surfaces of the building envelope.

The pressure factors given for the 1 200 mm zones near corners and near edges of roofs reflect a simplification of the AS/NZS 1170.2 factors for peak local pressures known to occur in these areas of buildings. Comparisons of pressure coefficients from the simplified local pressure model in this document and the more complex model in AS/NZS 1170.2 showed that the underestimations and overestimations were relatively small.

The local pressure model in this document recognizes that the high local pressure acts on around 25 % of a structural unit in order to classify it as attracting higher pressures. Therefore, windows with 25 % or more width of a single pane within 1 200 mm of the building edge are classified for pressures as SC (corner). A single pane will respond independently of the rest of the elements in the window. For doors, the single element is the opening leaf on a single door, one opening leaf on a double door. Therefore, doors with 25 % or more of the width of one opening leaf within 1 200 mm of the building edge are classified as SC not G.

Pressures on solar panels are complex and are governed by variables such as area of the photovoltaic panels, their location on the roof and the geometry of the whole building. Research in this area is continuing, and in future versions of AS 4055, appropriate simplified models for determining loads on roofs incorporating solar panels may be included. In the interim, users are referred to Appendices in AS/NZS 1170.2.

This document provides the net uplift at the roof to wall connection (Table 4), but not the net uplift at the base of the walls or at the connection to the sub-floor structure. For houses with floors closer than 1 800 mm to the averaged ground, it is valid and conservative to use the roof to wall pressures as applying to the connections lower in the structure. For houses with floors more than 1 800 mm above the averaged ground, AS/NZS 1170.2 provides pressure coefficients on the underside of the floor that may increase the tie down forces between the floor and the subfloor.

A.5 Section 5 — Pressures for determination of racking forces

A.5.1 General

This clause describes how the equivalent pressures tabulated in Section 5 for use with projected areas, for the calculation of racking loads to be resisted by bracing have been derived. The methods of determination of equivalent pressures for the calculation of racking forces in orthogonal directions for single or upper storey, for lower of two storeys and for subfloor level are given.

A.5.2 Notation

Notation symbols for Clause A.5 are closer to the notation in AS/NZS 1170.2. This is so that its origin in that document can be followed to the source. The notation in Clause A.5 is as follows:

b = plan dimension of building or part of building perpendicular to wind direction, in metres, refer to AS/NZS 1170.2

$C_{pt,roof}$ = combined pressure coefficient for the windward and leeward roof areas

$C_{pt,wall}$ = combined pressure coefficient for the windward and leeward walls

d = plan dimension of building or part of building parallel to the wind direction, in metres, refer to AS/NZS 1170.2

H_F = depth of upper floor, in metres

H_L = height, floor to ceiling for lower storey of two storeys, in metres

H_u = height, floor to ceiling for single or upper storey, in metres

h = height to eaves, in metres, refer to AS/NZS 1170.2

K_a = area reduction factor

K_c = pressure combination factor

L = length of building, in metres, see Figure A.5.3.

q_u = free stream dynamic gust pressure, in kPa, for the ultimate limit state in accordance with Clause 3.3

W = width of building, in metres, see Figure A.5.3

α = roof pitch, in degrees, refer to AS/NZS 1170.2 and see Figure A.5.3

θ = wind direction, in degrees, refer to AS/NZS 1170.2

A.5.3 Assumptions

The following assumptions have been made in the derivation of equivalent pressures for use with projected areas for the determination of racking forces:

(a) The geometry assumed is a simple outline of the building, which ignores eaves overhangs, fascias and gutters. The projected area for the roof is taken as the area above ceiling level for the single or upper storey, see Figure A.5.3.

(b) Buildings are assumed enclosed underneath the lower floor.

(c) The floor depth of upper floors (H_F) is assumed to be 0.3 m.

(d) H_u = H_L = 2.4 m. Pressures calculated for 2.4 m floor to ceiling heights are assumed to apply for walls up to 3.0 m high.

(e) A pressure combination factor K_c = 0.8 is applied where the load effect is the result of the combination of pressures on two or more surfaces.

NOTE K_c is not applied in combination with the area reduction factor (K_a).

(f) The assumed combined pressure coefficients for the windward and leeward walls ($C_{pt,wall}$) for wind directions θ = 0° and θ = 90° are given in Tables A.5.3(A) and Table A.5.3(B) respectively.

(g) The assumed combined pressure coefficients for the windward and leeward roofs ($C_{pt,roof}$) for wind parallel to the slope (pitch) of roof are given in Table A.5.3(C).

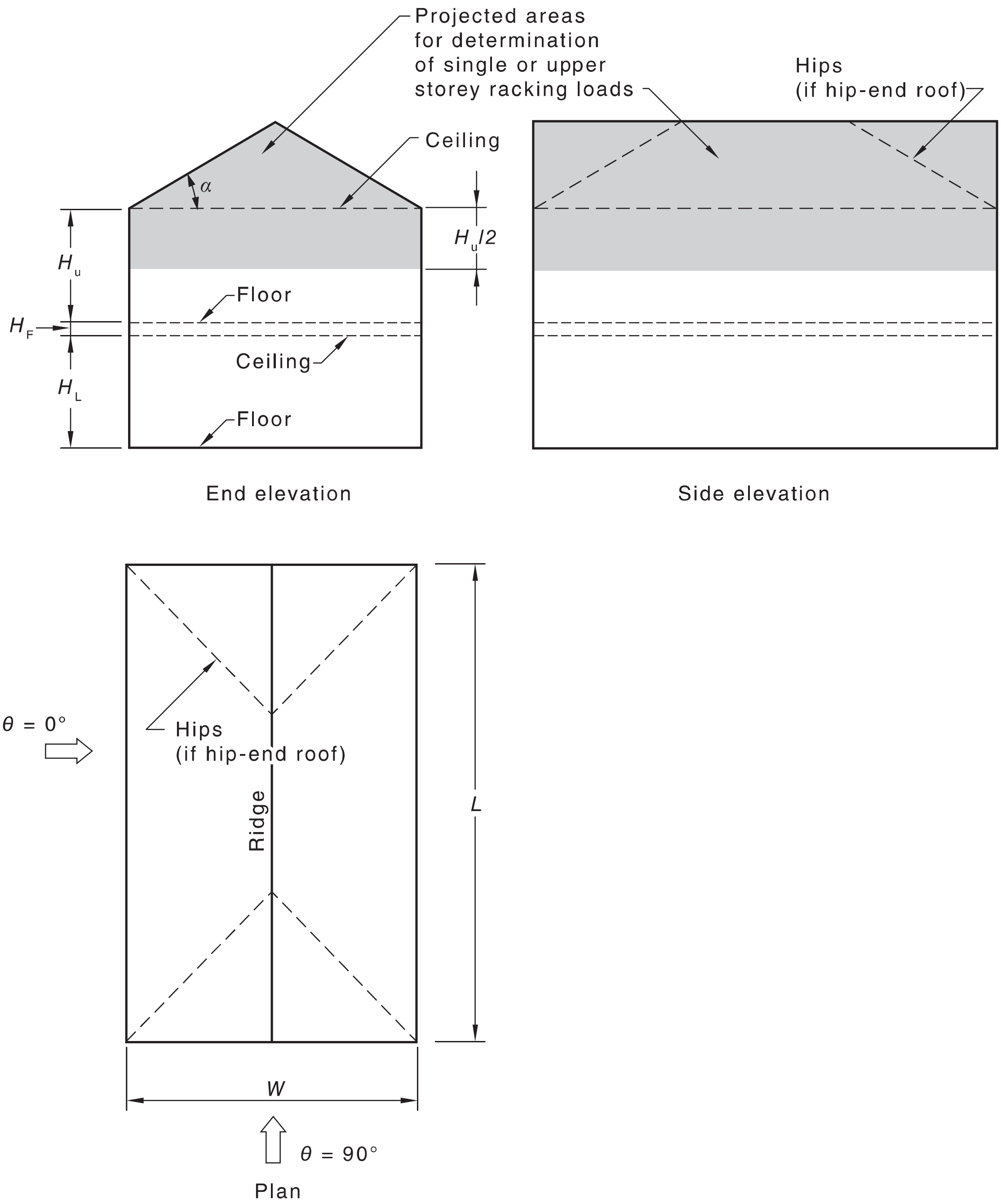


Figure A.5.3 — Notation

Table A.5.3(A) — Combined pressure coefficients for walls — Wind direction parallel to roof slope[a]

Roof pitch (α)	$\alpha < 10°$	$10° \le \alpha \le 15°$	$\alpha = 20°$	$\alpha \ge 25°$
$C_{pt,wall}$	1.1	1.1	1.1	1.2

[a] For all roofs, wind is parallel to the roof slope for $\theta = 0°$ and for hip ends also for $\theta = 90°$.

Table A.5.3(B) — Combined pressure coefficients for walls — Wind direction perpendicular to roof slope[a]

d/*b*	≤ 1	2	≥ 4
$C_{pt,wall}$	1.2	1.0	0.9

[a] For θ = 90° for gable or skillion roof ends the wind is perpendicular to the roof slope.

Table A.5.3(C) — Combined pressure coefficients for roofs — Wind direction parallel to roof slope[a]

Ratio *h*/*d*	$C_{pt,roof}$ Roof pitch (α)						
	< 10°	10°	15°	20°	25°	30°	35°
≤ 0.25	0	0	+0.5	+0.8	+0.9	+0.9	+1.0
0.5	0	+0.1	+0.2	+0.6	+0.8	+0.8	+0.9
≥ 1.0	0	+0.1	+0.1	+0.3	+0.6	+0.8	+0.8

[a] For all roofs, wind is parallel to the roof slope for θ = 0° and for hip ends also for θ = 90°.

A.5.4 Equivalent pressures on projected areas

A.5.4.1 For flat wall surfaces, gable or skillion roof ends

The equivalent pressure (p) on the projected area shown in Figure A.5.4.1 for calculation of the racking load for bracing in single or upper storey, or the lower of two-storey or subfloor walls is determined from the following equation:

$$p = q_u C_{pt,wall} K_c \quad \text{A.5.4.1}$$

where

$C_{pt,wall}$ = 1.2, as given in Table A.5.3(B) for d/b = 1

K_c = 0.8, pressure combination factor applicable for the combined effect of pressure on two or more surfaces

NOTE The assumption that d = b, i.e. L = W corresponds to the maximum combined pressure coefficient for the walls.

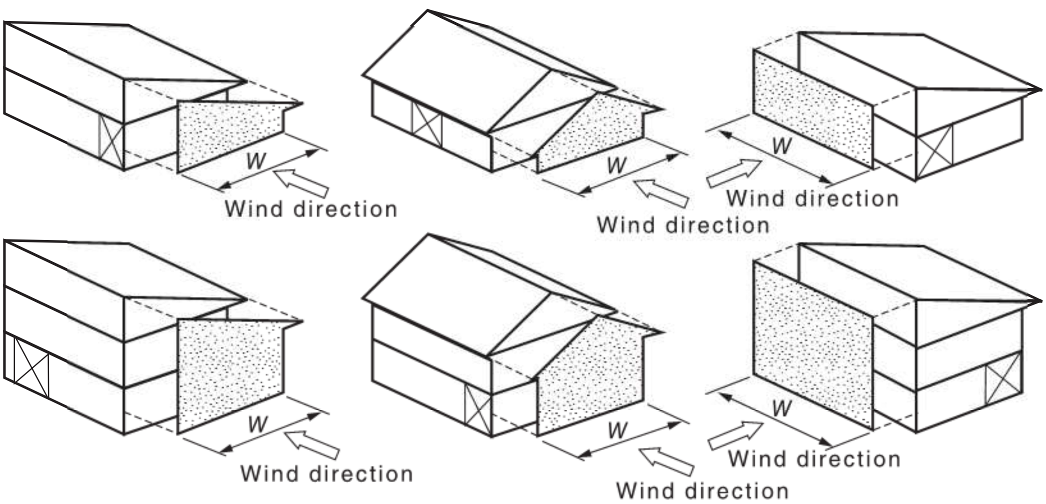


Figure A.5.4.1 — Flat wall surfaces — Gable and skillion roof ends

A.5.4.2 For side elevations, single or upper storey, gable- or hip-ended roofs

The equivalent pressure (p) for the projected areas shown in Figure A.5.4.2 for calculation of the racking load for bracing in single or upper storey walls is determined from the following equation:

$$p = \frac{q_u K_c \left[C_{pt,wall} (H_u/2) + C_{pt,roof} (W/2) \tan\alpha \right]}{(H_u/2) + (W/2)\tan\alpha} \quad \text{A.5.4.2}$$

where

$C_{pt,wall}$ = value from Table A.5.3(A) for roof pitch, α

$C_{pt,roof}$ = value from Table A.5.3(C), for roof pitch α assuming $(h/d) = (H_u/W)$

K_c = 0.8, pressure combination factor

NOTE 1 The assumption that $h/d = H_u/W$ maximizes the assumed combined pressure coefficients for the roof.

NOTE 2 The reduction in projected area for hip-ended roofs has been ignored in the determination of the equivalent pressures to be applied to the projected areas corresponding to either gable- or hip-ended roofs.

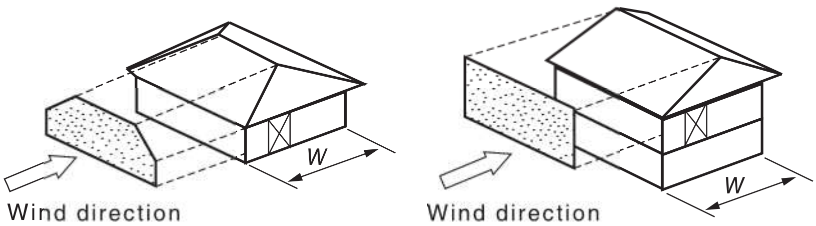


Figure A.5.4.2 — Side elevations — Single or upper storey — Gable or hip-ended roofs

A.5.4.3 Side elevation, lower storey of two storeys or subfloor, gable- or hip-ended roof

The design wind pressure (p) on the projected area shown in Figure A.5.4.3 for calculation of the racking force for bracing in the lower storey of two-storey walls is determined from the following equation:

$$p = \frac{q_u K_c \left[C_{pt,wall} \left(H_u + H_F + H_L/2 \right) + C_{pt,roof} \left(W/2 \right) \tan\alpha \right]}{\left(H_u + H_F + H_L/2 \right) + \left(W/2 \right) \tan\alpha} \quad \text{A.5.4.3}$$

where

$C_{pt,wall}$ = value determined from Table A.5.3(A) for roof pitch (α)

$C_{pt,roof}$ = value from Table A.5.3(C), for roof pitch α assuming $(h/d) = (H_u + H_F + H_L)/W$

K_c = 0.8, pressure combination factor

NOTE 1 The assumption that $(h/d) = (H_u + H_F + H_L)/W$ maximizes the assumed combined pressure coefficients for the roof.

NOTE 2 The reduction in projected area for hip-ended roofs has been ignored in the determination of equivalent pressures to be applied for projected areas for either gable or hip-ended roofs.

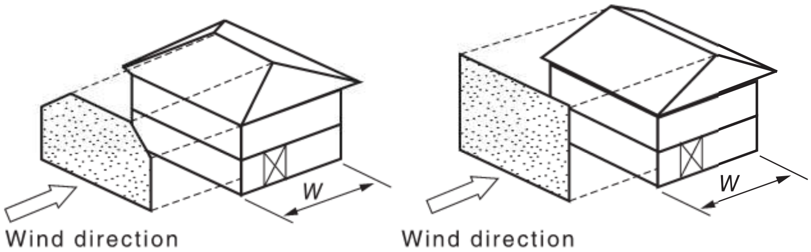


Figure A.5.4.3 — Side elevation — Lower storey of two storeys or subfloor — Gable or hip-ended roof

A.5.4.4 End elevation, single or upper storey, hip-ended roof

The design wind pressure (p) on the projected area shown in Figure A.5.4.4 for calculation of racking loads for bracing in single or upper storey walls is determined from the following equation:

$$p = \frac{q_u K_c \left[C_{pt,wall}\left(H_u/2\right) + C_{pt,roof}\left(W/4\right)\tan\alpha\right]}{\left(H_u/2\right) + \left(W/4\right)\tan\alpha} \quad \text{A.5.4.4}$$

where

$C_{pt,wall}$ = 1.2

$C_{pt,roof}$ = value obtained from Table A.5.3(C) for roof pitch (α) assuming $\left(h/d\right) = \left(H_u + H_F + H_L\right)/L$ and $1.5W$

K_c = 0.8, pressure combination factor

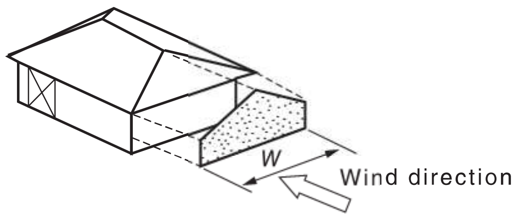


Figure A.5.4.4 — End elevation — Single or upper storey — Hip-ended roof

A.5.4.5 End elevation, lower storey of two storeys, hip-ended roof

The equivalent pressure (p) on the projected area shown in Figure A.5.4.5 for calculating racking loads for bracing in walls of the lower storey of two-storey walls is determined from the following equation:

$$p = \frac{q_u K_c \left[C_{pt,wall}\left(H_u + H_F + H_L/2\right) + C_{pt,roof}\left(W/4\right)\tan\alpha\right]}{\left(H_u + H_F + H_L/2\right) + \left(W/4\right)\tan\alpha} \quad \text{A.5.4.5}$$

where

$C_{pt,wall}$ = 1.2

$C_{pt,roof}$ = value from Table A.5.3(C), for roof pitch α assuming

$\left(h/d\right) = \left(H_u + H_F + H_L\right)/L$ and $1.5W$

K_c = 0.8, pressure combination factor

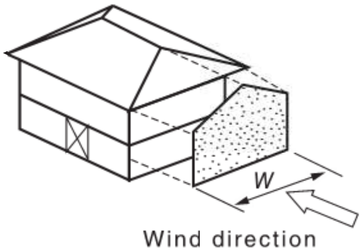


Figure A.5.4.5 — End elevation — Lower storey of two storeys — Hip-ended roof

A.6 Converting wind speeds

Wind speeds may be approximately converted from metres per second (m/s) to other commonly reported measures of speed as follows:

1 m/s × 3.6 = 1 km/h

1 m/s × 1.94 = 1 kn

1 m/s × 2.24 = 1 mile/h

Appendix B
(informative)

Determination of topographic class example

B.1 General

In order to show how to determine the appropriate topographic class, the following two examples are provided:

(a) Houses on an escarpment which relates to Figure B.2.

(b) Houses on more complex topography which relates to Figure B.3.

Each example has two individual house sites shown. In practice, this document will generally be used for one house site at a time.

B.2 Houses on an escarpment

Figure B.2 shows an escarpment with the slope rising steadily from 20 m to around 120 m at the top.

The process focuses on a line drawn through the site being considered.

Steps 1 to 4 establish the line and evaluate the slope of that line.

Steps 5 to 7 take into account the location of the house site relative to the top of the topographic feature.

Site A

Step 1 Identify the cross-section of interest through the site and the top of the cross-section. The line of interest is perpendicular to the contour lines which for Site A, takes it through the high point of the escarpment: RL 120 m. This is the top of the cross-section.

Step 2 Identify the bottom of the cross-section: RL 10 m (Bottom of the slope where the contours spread out indicating a slope of less than 1 in 20. Between 10 m and 20 m the contours are around 150 m apart, which makes the slope a little steeper than 1:20).

Calculate height of the feature as 120 m – 10 m = 110 m.

Step 3 Calculate the mid-height of the cross-section: (120 + 10)/2 = RL 65 m.

Step 4 Identify the following three zones of the escarpment:

(a) Lower third zone will be below contour 10 + 110 × 1/3 = 47 m.

(b) Top third zone will be above contour 10 + 100 × 2/3 = 83 m.

(c) Middle third zone will be between contour 47 m and 83 m.

Step 5 Identify the location of the site on the cross-section. Site A is at RL 105, so is higher than the 83 m contour and is in the top third of the slope.

Step 6 Identify the steepest slope through the site in the top half of the cross-section as follows:

(a) Mark 65 m contour and 120 m contour. The distance between them is 260 m (scaled off the contour plot).

(b) Steepest slope through the site over the top half of the cross-section = (120 – 65)/260 = 0.21.

(c) This can be expressed as 1:run by taking the inverse 1/0.21 = 1:4.72 or as an angle by finding the angle with a tan of 0.21, $\tan^{-1}(0.21) = 12.0°$.

Step 7 Use Table 2.4 to assign a topographic classification as follows:

(a) The escarpment has a maximum slope of 1:4.7 or 12° which is just inside the range of the fifth row of figures in Table 2.4.

(b) Site A is in the top third of the escarpment with the feature 110 m high and Table 2.4 gives a topographic classification of T4.

Site B

Step 1 Identify the cross-section of interest through the site and the top of the cross-section. The line of interest is perpendicular to the contour lines which for Site B, takes it north of the high point of the escarpment: RL 110 m. This is the top of the cross-section.

Step 2 Identify the bottom of the cross-section: RL 10 m (Bottom of the slope where the contours spread out indicating a slope of less than 1 in 20. Between 10 m and 20 m the contours are around 160 m apart, which makes the slope a little steeper than 1:20).

Calculate height of the feature as 110 m – 10 m = 100 m.

Step 3 Calculate the mid-height of the cross-section: (110 + 10)/2 = RL 60 m.

Step 4 Identify the following three zones of the escarpment:

(a) Lower third zone will be below contour 10 + 100 × 1/3 = 43 m.

(b) Top third zone will be above contour 10 + 100 × 2/3 = 77 m.

(c) Middle third zone will be between contour 43 m and 77 m.

Step 5 Identify the location of the site on the cross-section. Site B is at RL 30, so is lower than the 43 m contour and is in the lower third of the slope.

Step 6 In this case Step 6 can be omitted as any site in the lower third of the cross-section has a topographic class of T0 (independent of slope) There is no need to identify the steepest slope through the site in the top half of the cross-section

Step 7 Use Table 2.4 to assign a topographic classification as follows:

(a) The maximum slope is not required.

(b) Site B is in the lower third of the cross-section and Table 2.4 gives a topographic classification of T0.

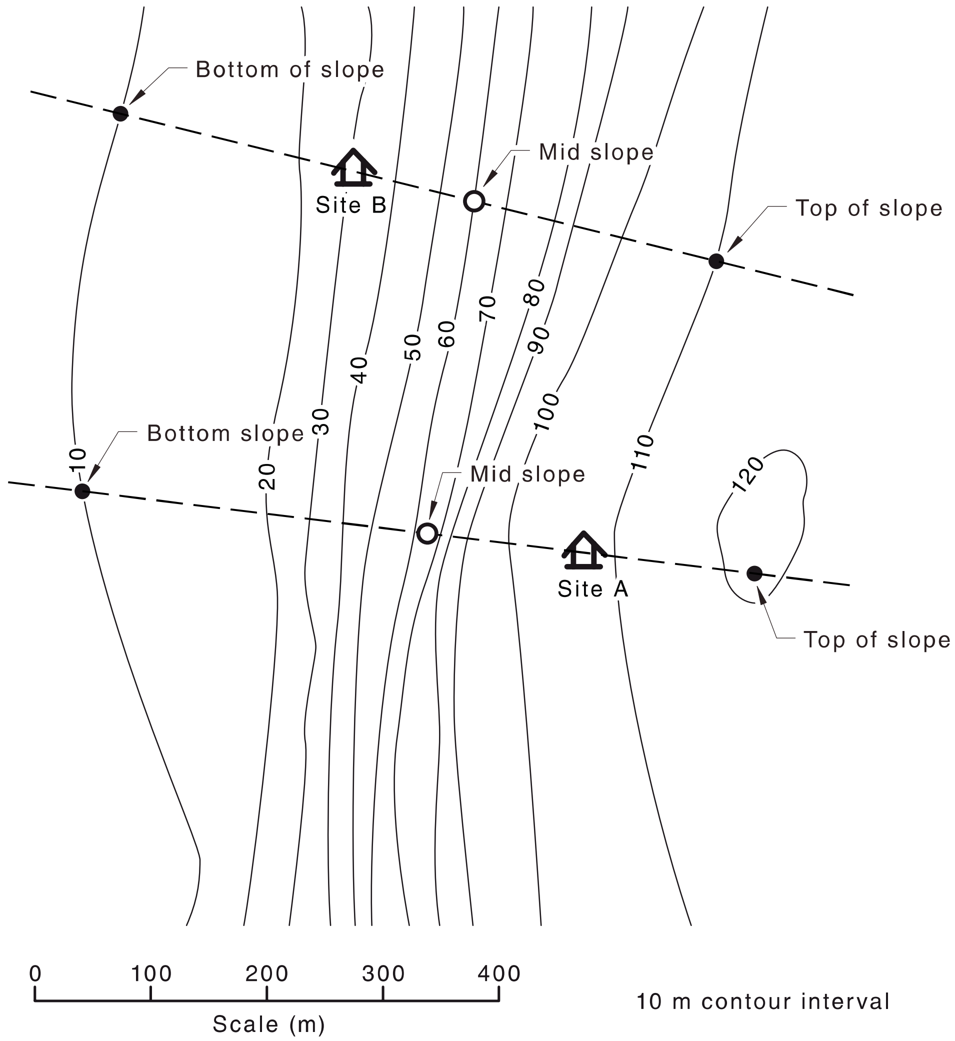


Figure B.2 — Example of topographic class — Sites A and B on an escarpment

B.3 Houses on a hill

Site C

The house site C is on the flanks of Hill 1 but also sits just below crest of a ridge leading to the top of the hill.

Step 1 Identify the cross-section of interest through the site and the top of the cross-section. For Site C, the line of interest goes from the creek to the top of the ridge just above the house. (By continuing past the ridge, the line descends into a valley and has not risen to the same level as the top of the ridge within 200 m. The top of the ridge at the marked line is RL 90 m.)

Step 2 Identify the bottom of the cross-section: The creek is at around RL 40 m. On the other side of the creek line, the ground is rising, so the creek is at the bottom of the cross-section.

Calculate the height of the feature as 90 m – 40 m = 50 m.

Step 3 Calculate the mid height of the cross-section: (90 + 40)/2 = RL 65 m.

Step 4 Identify the following three zones of the feature:

(a) Lower third zone will be below contour 40 + 50 × 1/3 = 57 m.

(b) Top third zone will be above contour 40 + 50 × 2/3 = 73 m.

(c) Middle third zone will be between contour 57 m and 73 m.

Step 5 Identify the location of the site in the cross-section. Site C is at RL 75 m, so is just in the top third of the cross-section.

Step 6 Identify the steepest slope through the top half of the cross-section as follows:

(a) Mark 65 m contour and 90 m contour. The plan distance between them is 100 m (scaled off the contour plot).

(b) Steepest slope through the site = (90 – 65)/100 = 0.25.

(c) This can be expressed as 1:run by taking the inverse 1/0.25 = 1:4.0 or as an angle by finding the angle with a tan of 0.25, $\tan^{-1}(0.25) = 14.0°$.

Step 7 Use Table 2.4 to assign a topographic classification as follows:

(a) The cross-section has a maximum slope of 1:4.0 or 14° which is inside the range of the fifth row of figures in Table 2.4.

(b) Site C is in the top third of the cross-section 50m high and Table 2.4 gives a topographic classification of T4.

Site D

Step 1 Identify the cross-section of interest through the site and the top of the cross-section. For Site D, the line of interest goes from the creek to the south to the top of the saddle at the house. (By continuing past the ridge, the line descends into a valley and has not risen to the same level as the top of the ridge within 200 m. The top of the ridge at the marked line is RL 100m.)

Step 2 Identify the bottom of the cross-section: The creek to the south of the site is at around RL 35 m. On the other side of the creek line, the ground will be rising, so the creek is at the bottom of the cross-section.

Calculate the height of the feature as 100 m – 35 m = 65 m.

Step 3 Calculate the mid height of the cross-section: (100 + 35)/2 = RL 67.5 m.

Step 4 Identify the following three zones of the feature:

(a) Lower third zone will be below contour 35 + 65 × 1/3 = 57 m.

(b) Top third zone will be above contour 35 + 65 × 2/3 = 78 m.

(c) Middle third zone will be between contour 57 m and 78 m.

Step 5 Identify the location of the site in the cross-section. Site D is at RL 95 m, so is in the top third of the cross-section

Step 6 Identify the steepest slope through the top half of the cross-section as follows:

(a) Mark 67.5 m contour and 100 m contour. The plan distance between them is 140 m (scaled off the contour plot).

(b) Steepest slope through the site = (100 – 67.5)/140 = 0.23.

(c) This can be expressed as 1:run by taking the inverse 1/0.23 = 1:4.3 or as an angle by finding the angle with a tan of 0.23, $\tan^{-1}$ (0.23) = 13.

Step 7 Use Table 2.4 to assign a topographic classification for site D as follows:

(a) The cross-section has a maximum slope of 1:4.3 or 13° which is inside the range of the fifth row of figures in Table 2.4.

(b) Site D is in the top third of the cross-section 65 m high and Table 2.4 gives a topographic classification of T4.

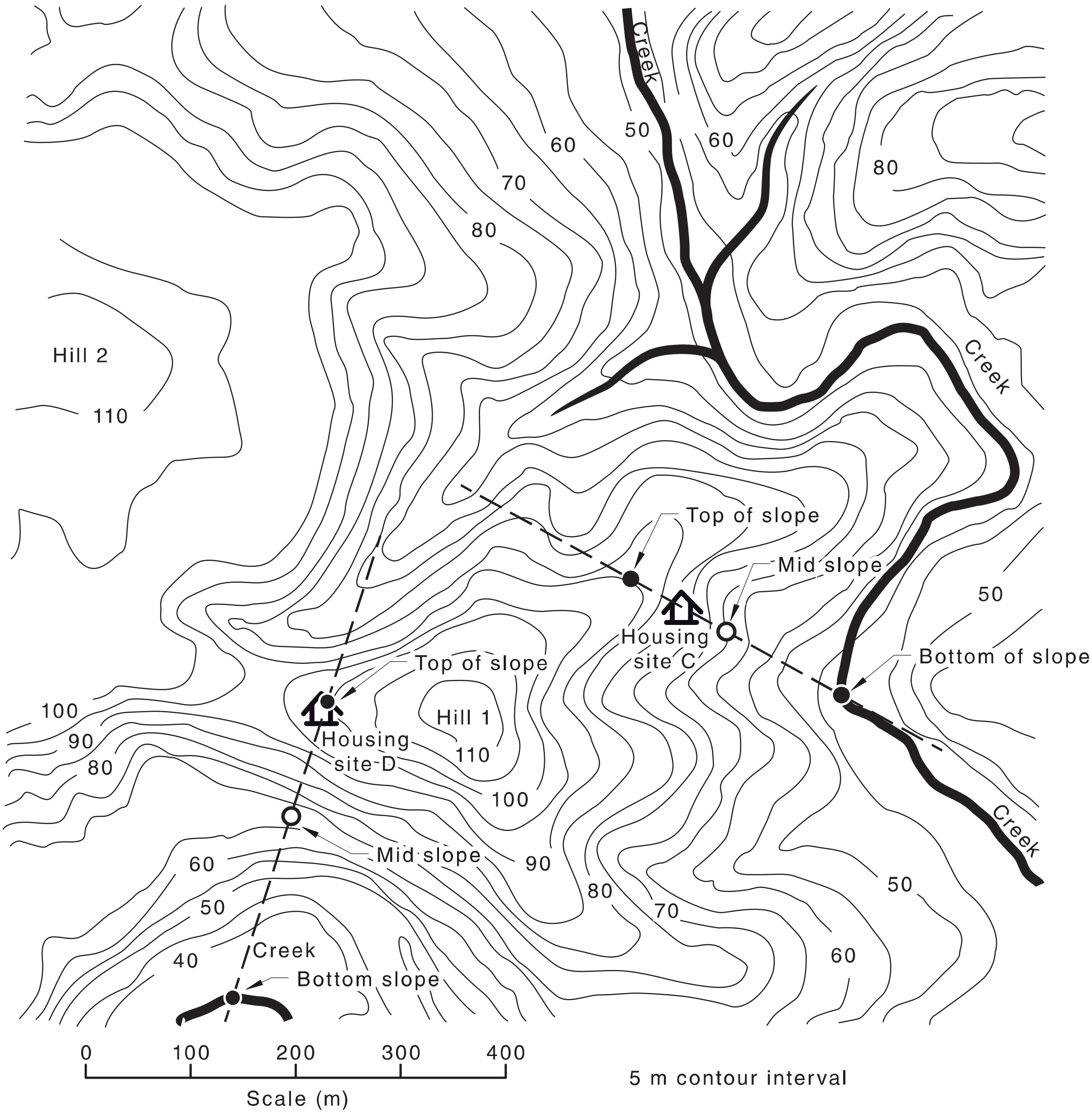


Figure B.3 — Example of topographic class — Sites C and D

Appendix C
(informative)

Selection of terrain category and shielding class examples

C.1 General

The typical surface roughness types encountered in an urban area are represented in Table C.3(A), and in outer suburban areas in Table C.3(B). These examples are provided to assist in the selection of terrain categories and shielding classes of particular sites.

In conjunction with deriving the correct topographic class from Table 2.4, the terrain category and shielding class selected for each site are applied to Table 2.2 for the appropriate geographic region to determine the rationalized wind class for the design of houses or structures.

C.2 Example A

The site at Location A, shown in Table C.3, is in the second row of houses facing open water such as an ocean or larger bay. The site may be thought of as a part of suburbia, but the terrain and shielding are classified as follows:

(a) A 500 m radius circle centred on the house site will take in some of the open water. The smoothest terrain within the circle will be the water with a terrain category (TC) of 1.

(b) For shielding, this site has at least one side (the side facing the water) which has only one row of houses that can be regarded as shielding. It is therefore classified as "partially shielded" (PS). Even though there may have been three sides of the site that had many rows of houses, it is the side with the least shielding that dictates the shielding class.

The terrain category of the site is therefore TC1 and the Shielding Class PS.

Sites should be more than 500 m from the ocean shore before they can be classed as TC3.

C.3 Example B

The site at Location B, shown in Table C.3, is sited more than two rows back from the edge of a very large area of parkland. While the site is surrounded by normal suburban housing, the terrain and shielding are classified as follows:

(a) A 500 m radius circle centred on the house site will take in some of the large park. The smoothest terrain within the circle will be the open terrain of the park with a terrain category (TC) of 2.

(b) For shielding, this site has all sides with at least two rows of houses that can be regarded as shielding. It is therefore classified as "fully shielded" (FS).

The terrain category of the site is therefore TC2 and the Shielding Class FS.

Sites should be more than 500 m from the large park before they can be classed as TC3.

Table C.3 — Example of terrain category and shielding classification where there is open water, suburban housing and a large park

Description	Ocean	Waterfront suburbia			Residential suburbia				Large park > 250 000 m²
Surface roughness	Open Water (TC1)	Houses > 10 per hectare (TC3)							Scattered trees (TC2)
Design TC for houses in this area	N/A	500 m → TC1 [A]			TC3	← 500 m TC2 [B]			N/A
Shielding for houses in this area	N/A	1st row NS	2nd row PS	> 2nd row FS	FS	> 2nd row FS	2nd row PS	1st row NS	N/A
Design criteria for houses in this area	N/A	TC1, NS	TC1, PS	TC1, FS	TC3. FS	TC2. FS	TC2, PS	TC2, NS	N/A

C.4 Example C

The site at Location C, shown in Table C.5, is sited immediately adjacent to a small park with a width of 150 m, but an area of less than 250 000 m^2. Because the park is relatively small, the site is still regarded as being within normal suburbia.

(a) A 500 m radius circle centred on the house site will take in the small park, but the park is too small (<250 000 m^2) to allow the wind to speed up as it passes over. This document ignores small parks in classifying terrain. The smoothest terrain within the circle will therefore be the suburban housing with a terrain category (TC) of 3.

(b) For shielding, this site has at least one side with no houses that can be regarded as shielding (the side facing the small park). It is therefore classified as Not Shielded (NS).

The terrain category of the site is therefore TC3 and the Shielding Class NS.

NOTE The small park in this case was big enough to affect the shielding (more than 20 m wide), but small enough not to affect the terrain roughness (less than 200 m wide).

C.5 Example D

The house site at Location D, shown in Table C.5, is within an acreage development with fewer than 10 houses per hectare anticipating development after five years.

(a) A 500 m radius circle centred on the house site will take in the acreage development and some nearby suburban housing. The smoothest terrain within the circle will be the acreage development with a terrain category (TC) of 2.5.

(b) For shielding, this site will have houses on all sides, but as they are sparse, it is therefore classified as “partially shielded” (PS).

The terrain category of the site is therefore TC2.5 and the Shielding Class PS.

NOTE The first row of housing in the normal suburban development has some shielding on the side of the acreage development, so even though it is the first row of suburbia, it takes the same shielding as the acreage development.

Table C.5 — Example of terrain category and shielding classification where there is closed water and suburban and acreage housing

Description	Lake	Waterfront suburbia			Residential suburbia			Small park < 250 000 m^2, 150 m across	Residential suburbia					Acreage suburbia
Surface roughness	Closed water (TC1)	Houses > 10 per hectare (TC3)						Scattered trees in small area	Houses > 10 per hectare (TC3)					Houses < 10 per hectare (TC2.5)
Design TC for houses in this area	N/A	500 m → TC1			TC3 C			N/A	TC3			← 500 m TC2.5		TC2.5 D
Shielding for houses in this area	N/A	1st row NS	2nd row PS	> 2nd row FS	> 2nd row FS	2nd row PS	1st row NS	N/A	1st row NS	2nd row PS	> 2nd row FS	> 1st row FS	1st row PS	PS
Design Criteria for houses in this area	N/A	TC1, NS	TC1, PS	TC1, FS	TC3, FS	TC3, PS	TC3, NS	N/A	TC3, NS	TC3, PS	TC3, FS	TC2.5, FS	TC2.5, PS	TC2.5, PS

Appendix D
(informative)

Racking forces example

The example given in this appendix, using ultimate limit states design, shows the method of determining racking forces on a two-storey house located in Region B, TC2.5, having partial shielding and a topographic classification T2.

For the example, assume that the house is 16 m long, 8 m wide and has a 17.5° pitched, gable-end roof.

Step 1 From Table 2.2 (for Region B, TC2.5, T2 and PS) the wind class is N4.

Step 2 Calculate the upper storey racking for wind normal to ridge (wind on side).

From Table 5.2(H), for W = 8 m and roof slope = 17.5°, the pressure for wind on side is determined: (1.35 + 1.56)/2 = 1.46 kPa.

Determine area on which the pressure is to be applied and multiply the area by the pressure to give the racking force in kN. Provide bracing appropriate to resist this force.

Step 3 Calculate the upper storey racking for wind parallel to ridge (wind on end).

From Table 5.2(H), for W = 8 m and roof slope = 17.5°, the pressure for wind on end is determined: (1.65 + 1.77)/2 = 1.71 kPa.

Determine area on which the pressure is to be applied and multiply the area by the pressure to give the racking force in kN. Provide bracing appropriate to resist this force.

Step 4 Calculate lower storey racking for wind normal to ridge (e.g. wind on side).

From Table 5.2(I), for W = 8 m and roof slope = 17.5°, the pressure for wind on side is determined: (1.54 + 1.61)/2 = 1.58 kPa.

Determine area on which the pressure is to be applied and multiply the area by the pressure to give the racking force in kN. Provide bracing appropriate to resist this force.

Step 5 Calculate lower storey racking for wind parallel to ridge (wind on end).

From Table 5.2(I), for W = 8 m and roof slope = 17.5°, the pressure for wind on end is determined: (1.84 + 1.87)/2 = 1.86 kPa.

Determine area on which the pressure is to be applied and multiply the area by the pressure to give the racking force in kN. Provide bracing appropriate to resist this force.

Bibliography

AS 3959, *Construction of buildings in bushfire-prone areas*

ABCB, *National Construction Code (NCC)*

NOTES

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