



AUSTRALIAN STEEL INSTITUTE  
STEEL SHED GROUP

# Design Guide

## Wind Actions on Steel Sheds & Garages



## WHAT THIS PUBLICATION IS ABOUT

This publication outlines the principles of design wind actions on *steel sheds and garages* for construction in Australia.

It has been published to assist shed suppliers and building certifiers determine the correct building specification and site wind speed for steel sheds and garages.

It does not replace the Building Code of Australia (BCA), its referenced standards and other engineering texts but should be read in conjunction with them.

## ISNT A SHED JUST A SHED?

Whilst Sheds may have historically been class 10a garages and rural buildings, Steel Sheds are now widely used for Institutional, Recreational, Commercial, Emergency Services, and Industrial applications.

A shed just isn't a shed anymore.

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## ABOUT ASI STEEL SHED GROUP

The Australian Steel Institute, Steel Shed Group is a special interest group founded at the request of Industry. The group is self-funded by members. The Steel Shed Group promotes compliance for engineering and documentation standards for the steel shed industry via technical publications, education and creating awareness.

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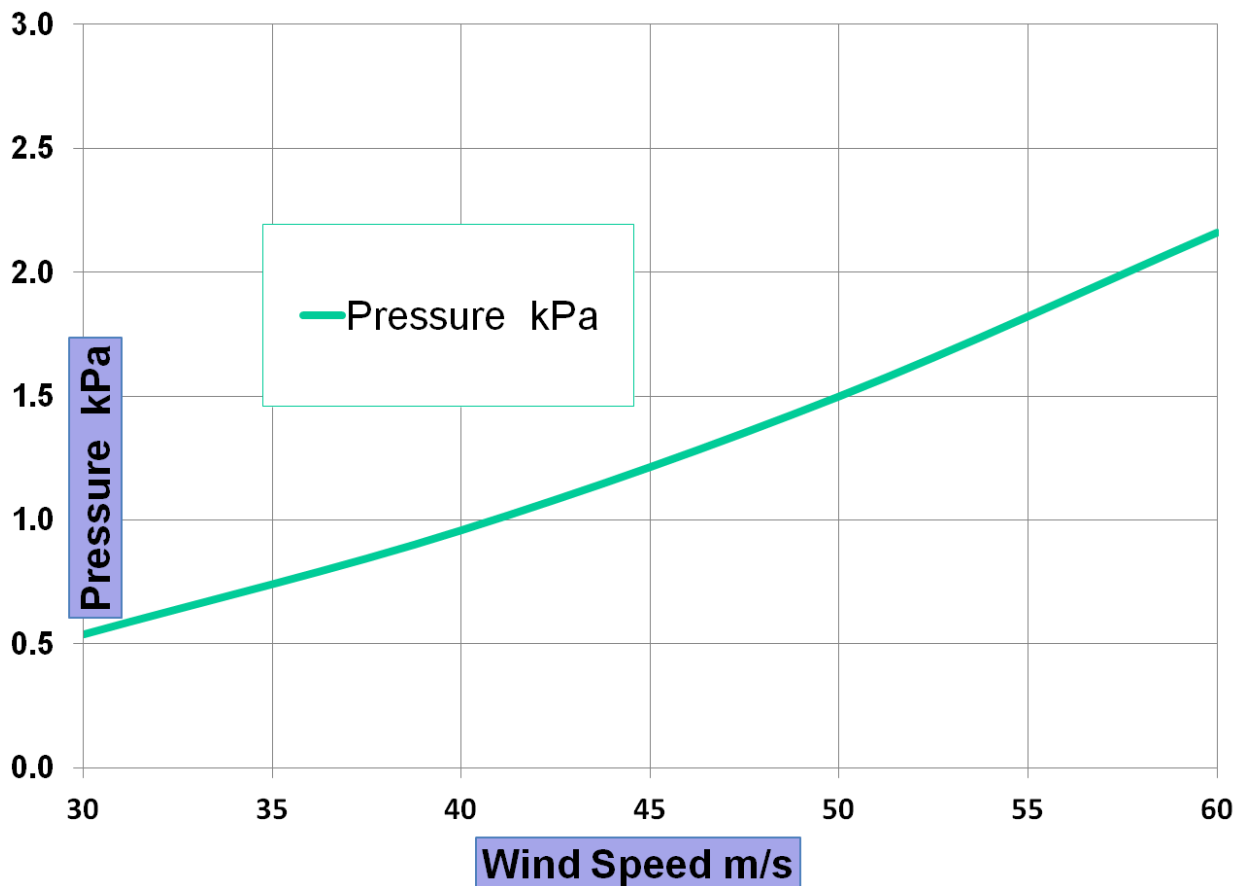
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# WHY ARE WIND ACTIONS SO CRITICAL TO STEEL SHED DESIGN?

Wind Actions will in most cases be the governing load case in the design of a steel shed.

As the design wind pressure is the square of the wind speed (see graph below) it is critical the intended site has the site wind speed correctly assessed.



# THE RIGHT SPECIFICATION-THE RIGHT SHED

Each building and its location are unique and must meet the appropriate importance level and building classification.

The site conditions for the Shed must be correctly assessed to ensure the correct site wind speed is supplied and constructed.

An underspecified shed is a much higher risk of failure.

Some consumers may wish to purchase a more robust design than is required for their intended site.

# DETERMINING CORRECT SPECIFICATION

## 1: Importance Level

BCA  
2012

Building authorities, on behalf of the community, regulate how strongly buildings are constructed to resist the loads they are expected to experience and what risk of structural failure is acceptable for various types and uses of building. The national regulator, the Australian Building Codes Board, expresses this community expectation via the Importance Levels in the BCA.

BCA 2011 explains that importance levels:

- Apply to *structural safety only*, not to serviceability or functionality;
- Are a function of both *hazard to human life* and *public impact* of building failure, and
- Must be assigned on a case by case basis.

The **Importance Level** can be determined from the following table:

BUILDING IMPORTANCE LEVEL					
CONSEQUENCES OF BUILDING FAILURE		IMPACT ON THE PUBLIC			
		Low	Moderate	Substantial	Extreme
HAZARD TO HUMAN LIFE	Low	1	2	2	3
	Moderate	2	2	3	3
	Substantial	2	3	3	4
	Extreme	3	3	4	4

Source: Guide to the BCA Section B1.2.

## Importance Level Examples

BCA 2012

BUILDING DESCRIPTION	BCA CLASS	FAILURE CONSEQUENCES		IMPORTANCE LEVEL
		HUMAN HAZARD	PUBLIC IMPACT	
Farm Shed	10a	Low	Low	1
Residential shed/garage/carport	10a	Mod	Low	2
Small school shade structure	9b	Mod	Mod	2
Produce sales building	6	Mod	Mod	2 or 3
Shearing shed	8	Sub	Mod	2
Large commercial storage warehouse	7b	Mod	Sub	3
Large (250+) school assembly shelter	9b	Sub	Sub	3
Shed housing hospital emergency generator	10a	Sub	Ext	4
Emergency vehicle garage	10a	Sub	Ext	4

Source: BCA Table B1.2a and Guide to the BCA Section B1.2.

The BCA requires that regional wind speeds of specific probability be used for building design. The more important the building, the less the allowable risk that the design speed will be exceeded in any one year and the higher the speed required in design. **Regardless of their importance level or classification, buildings should not fail when subjected to the wind event for which they are certified to withstand.**

The **Annual Probability of Exceedance for Wind Speed** is selected from the following table:

IMPORTANCE LEVEL	ANNUAL PROBABILITY OF EXCEEDANCE FOR WIND SPEED	
	NON-CYCLONIC	CYCLONIC
1	1:100	1:200
2	1:500	1:500
3	1:1000	1:1000
4	1:2000	1:2000

Source: BCA Table B1.2b

## 3 : Wind Region

Australia is divided into several regions based on the maximum wind speed expected during peak storm activity. The region associated with a particular building locality can be found from:

- o A structural engineer, building surveyor or certifier.

The following map shows the approximate location of the region boundaries. It should be taken only as a guide and the region verified by one of the above methods.



## 4 : Regional Wind Speed

AS/NZS 1170.2 Clause 3.2

The **Regional Wind Speed** – ultimate limit state - for the Region and Annual Probability of Exceedance is determined from the following table:

REGIONAL WIND SPEED				m/s	
Speed Probability	Region A	Region B	Region C	Region D	
$V_{100}$	41	48	59	73	
$V_{200}$	43	52	64	79	
$V_{500}$	45	57	69	88	
$V_{1000}$	46	60	74	94	
$V_{2000}$	48	63	77	99	

Source: AS/NZS 1170.2 Table 3.1 and Clause 3.4.

## 5 : Wind Direction Multiplier

AS/NZS 1170.2 Clause 3.3

**In Region A only**, where the final orientation of the building is *unknown*,  $M_d = 1.00$ . Where the final orientation of the building is *specified in design documentation*,  $M_d$  should be determined from AS/NZS 1170.2 Table 3.2. **In Regions B, C and D**,  $M_d = 0.95$  for forces on complete buildings and major structural members and 1.00 for all other design cases.

## 6 : Terrain/Height Multiplier

AS/NZS 1170.2 Clause 4.2

The **Terrain/Height multiplier** is determined from the following table:

Building Height (m)	Region A & B (Ultimate limit state)				Region C & D (Ultimate limit state)		
	All Regions (Serviceability limit state)						
	TC1	TC2	TC2.5	TC3	TC 1 & 2	TC2.5	TC 3
$\leq 3$	0.99	0.91	0.87	0.83	0.90	0.85	0.80
5	1.05				0.95	0.88	
10	1.12	1.00	0.92		1.00	0.95	0.89

Source: AS/NZS 1170.2 Table 4.1(A). Linear interpolation may be used for intermediate values of height and terrain category. Building Height is defined in AS/NZS 1170.2 Fig 2.1.

TC	Description
1	Exposed open terrain with few or no obstructions
2	Water surfaces, open terrain, grassland with few, well-scattered obstructions having heights generally from 1.5 m to 10 m.
2.5	Terrain with few trees, isolated obstructions such as agricultural land, cane fields or long grass, up to 600 mm high.
3	Terrain with numerous closely spaced obstructions 3 m to 5 m high such as areas of suburban housing.
4	Terrain with numerous large 10 m to 30 m high closely spaced obstructions such as large city centres and well-developed industrial complexes.

**Note:** Generic shed documentation should include the above descriptions to clarify the conditions for which the design is suitable. Definition and interpolated values for TC 2.5 are included for convenience. Designers should evaluate the actual terrain conditions and select the appropriate multiplier in accordance with AS/NZS 1170.2.

## 7 : Shielding Multiplier

AS/NZS 1170.2 Clause 4.3

The **Shielding Multiplier** is a *local development effect*. It reduces the design wind speed by taking into account the protection afforded by upwind local buildings. A Shielding Multiplier of 1.0 should be applied outside suburban areas unless a lower value is justifiable and supported by a competent site survey.

On suburban sites where all adjoining allotments are fully developed and the average upwind gradient is less than 0.2, a Shielding Multiplier of 0.85 may be applied as suggested in AS/NZS 1170.2 Supplement 1.

**Only permanent structures provide shielding. Trees and other vegetation do not provide shielding.**

For Wind Region A, if the intended structure isn't surrounded by permanent structures on all four sides an assessment can be made by a suitably qualified person to determine applicable shielding.

For Wind Regions B, C & D structures providing shielding must be located on all four sides of the shielded building.

Structures providing shielding are required be within 20x (20h) the average height of the structure it is intended to shield and be of comparable height.

A suburban site is defined as a fully developed area with a number of rows of streets.

## 8 : Topography Multiplier

AS/NZS 1170.2 Clause 4.4

The **Topography Multiplier** is a *local geographic effect*. It increases the design wind speed based on the gradient upwind of the site. Any site on a hill or escarpment of any size must be properly evaluated to determine the Topography Multiplier. A multiplier of 1.0 is not a conservative assumption. Whatever value is calculated or selected by the designer, the value and its corresponding site description should be clearly stated on all documentation.



## APPLICABLE WIND CODES

The BCA A3.1: defines "The classification of a building or part of a building is determined by the purpose for which it is designed, constructed or adapted to be used". A "shed" could be designed or adapted as virtually any class of building.

The BCA Volume 1 covers Class 2 to 9 buildings, some Class 10b structures and disabled access requirements in all buildings.

The BCA Volume 2 covers Class 1 and Class 10a buildings. A Class 10a building is "a non-habitable building being a private garage, carport, shed or the like".

For determination of wind actions, AS/NZS 1170.2 is referenced in both Volume 1 and 2 of the BCA. AS/NZS 1170.2 may be used to determine wind actions in virtually all situations for all building classes and all importance levels.

AS 4055 (Wind Loads for Housing) is referenced only in Volume 2 is limited by its Scope (housing) and Limitations (length, width, height & roof pitch). AS 4055 is only applicable for structures with an Importance Level 2 since annual probability of exceedance has been taken as 1:500.

If a building is not a house or is larger than the AS 4055 geometric limitations, or has an importance level higher than 2, AS 4055 cannot be used for determining wind actions and AS/NZS 1170.2 must be used.

**Designs developed using AS/NZS 1170.2 are legitimate for class10a sheds used in residential areas and should not be required to be referenced to AS 4055. The system of wind speed classes (i.e. N2, C1) is defined only in AS 4055 and is not used or referred to in AS/NZS 1170.2.**

## OBSELETE CODES

In some localities, the use of the 'W' wind classification system has persisted. This system relates to the 'permissible stress' design methodology, as described in AS 1170 – 1989.

With the implementation of the AS/NZS 1170 series of new standards in 2002, the previous wind load code AS 1170.2 - 1989 was superseded. The *farm structures code* AS 2867 was withdrawn from the BCA in 2007.

**Designs certified for use in cyclonic regions not based on LHL test data do not comply with the BCA and should not be approved.**



## WIND SPEED - WORKED EXAMPLE: REGION A (NON-CYCLONIC)

### BUILDING DESCRIPTION

- The project is a 6m x 6m x 3.0m high double garage with twin roller doors, in the vicinity of a house on a 1000sqm allotment in outer suburban Melbourne, less than 70km from Melbourne GPO. The precinct is fully developed with housing and associated buildings and structures. The building will be used for garaging private vehicles and other domestic activities such as workshop and storage. As a domestic building, it is a reasonable assumption that the main roller doors of the building will be closed during high winds, provided this assumption is communicated to and accepted by the owner.
  - *The building is not a dwelling, but its use is associated with domestic purposes.*
  - *The BCA Classification of the building is 10a, which is appropriate for a non-habitable shed, garage or carport. There are no structural implications of this classification.*
  - *The building doors will be assumed closed during peak wind events. Internal pressure consistent with enclosed buildings may be used for structural design.*

### SITE FACTORS

- Check region with Council.
  - *The Council has confirmed in writing that the allotment on which the proposed garage will be built is located in Region A5, as defined in AS/NZS 1170.2.*
- The consequences of structural failure are considered to be *moderate* in terms of human hazard (because the building is associated with domestic use) and *moderate* in terms of impact on the public (because the allotment is in a residential zone).
  - *Importance Level 2 is assigned – this is consistent with residential outbuildings generally. Importance Level 1 can only be justified if both hazard and impact of failure are low.*
  - *Importance Level 2 requires an annual probability of exceedance for wind events of 1:500.*
- The exact orientation of the building and roller door orientation may be design factors for an enclosed building in Region A5. However, in this case the design is to be based on “doors closed”.
  - *For Region A5, a wind direction multiplier of 1.00 is applied for all design cases. There is no dominant opening, so no structural design benefit can be gained by wind speed reduction in specific directions.*
- The general terrain of the property precinct is *suburban housing* in all directions. There is no reason to believe it would be redeveloped in any direction for non-housing purposes.
  - *The terrain is Category 3 with no change anticipated. A terrain/height multiplier of 0.83 is appropriate.*
- The proposed garage is well shielded by the house and other dwellings on adjoining blocks, with typically about 10 buildings in each direction. Effects of shielding should be considered.

- Evaluate shielding parameter ( $s$ ) from AS/NZS 1170.2 Clause 4.3.3:
  - Average height of shielding buildings ( $h_s$ ) is about 4 m.
  - Average breadth of shielding buildings ( $b_s$ ) is about 9 m.
  - Roof height of garage being shielded ( $h$ ) is 3 m.
  - Number of upwind shielding buildings ( $n_s$ ) is about 10.
  - Shielding parameter  $s = (3 \times (10/10 + 5))/(4 \times 9)^{0.5} = 3.0$
  - Look up shielding multiplier in Table 4.3,  $M_s = 0.8$
- The site and surrounding geography are essentially flat and level.
  - There is no reason to apply a topographic factor higher than 1.0.
- The steps in calculation of site wind speed are:
  - Look up regional wind speed for region A5 and 1:500,  $V_R = 45$
  - Wind directional multiplier for region A5,  $M_d = 1.00$
  - Look up terrain/height multiplier  $M_{z, cat} = 0.83$
  - Look up shielding multiplier  $M_s = 0.8$
  - Look up topography multiplier  $M_t = 1.0$
  - Calculate  $V_{sit} = V_R \times M_d \times M_{z, cat} \times M_s \times M_t$
  - **Value for this example,  $V_{sit} = 45 \times 1.00 \times 0.83 \times 0.8 \times 1.0 = 30 \text{ m/s}$**
  - In this case, as the building orientation is irrelevant this is also the design wind speed  $V_{des}$
- The calculated design wind speed is then used to calculate the design wind pressures acting on various parts of the structure in accordance with AS/NZS 1170.2 Clause 2.4.

# CYCLONIC DESIGN

## Internal Pressure Coefficients

AS/NZS 1170.2 Clause 5.3

The internal pressure coefficients selected by the designer depend mainly on the size, shape and orientation of the building and on the size and configuration of its openings. They also depend, in part, on the wind region in which the building is located.

In all regions, designers may use their discretion as to which openings are assumed closed during peak wind events, as explained in AS/NZS 1170.2 Supplement 1. However, *any such closed openings must be capable of withstanding peak wind forces under the critical loading conditions*. This means that, for example, a roller door rated at 1.0 kPa may only be assumed 'closed' during peak wind events if the highest calculated pressure on the door is no more than 1.0 kPa.

In cyclonic regions C and D, a further requirement applies. Designers must consider the resistance of the entire building envelope – windows, doors, roof and wall cladding – to impact by flying debris. Unless the designer is satisfied that the building envelope will be “*capable of resisting impact loading equivalent to a 4 kg piece of timber of 100x50 mm cross-section, projected at 15 m/s at any angle*”, as required by AS/NZS 1170.2 Clause 5.3.2, then he/she must select the most adverse internal pressure coefficients arising from building envelope failure. These coefficients are specified in AS/NZS 1170.2 Table 5.1(B).

## Low-High-Low Cyclic Test Method

During cyclonic events, elements of the building envelope are subjected to highly fluctuating wind loads which can cause the fatigue of material, reducing its strength. The Building Code of Australia May 2009 introduced a requirement that all metal roofing systems used in cyclonic regions shall demonstrate performance to a new standardised cycle test method.

This method is known as low-high-low (LHL) based on the low, then high, then low pressure sequence used to simulate the wind loads resulting from the passage of tropical cyclones across a building.

**The LHL test is applicable to metal roof cladding, its fasteners and immediate supporting members.** LHL does not currently apply to wall cladding.

Roofing manufacturers who comply with the BCA requirement for LHL testing have published revised product data for cyclonic regions which reflects the LHL test results. All previous test data for cyclonic regions is obsolete. The LHL test has proven to be more conservative than previous methods and has generally resulted in reduced spans for roof sheeting. Certification of Designs of structures including sheds and industrial buildings with metal roof cladding are required to be revised in accordance with manufacturers' LHL test data. Compliance with LHL requirements should be noted on specifications and plans referencing the manufacturer.

Roof cladding systems (metal roofing, fasteners & battens) installed on domestic housing are required to be installed in accordance with the roofing manufacturers published data for cyclonic regions that incorporates LHL test results.

BCA 2012 references:

BCA Vol 1 – Part B 1.2 (c) (iii) & (iv)

BCA Guide - Specification B1.2 Design of Buildings in Cyclonic Areas

BCA Vol 2 – Addition Constructions Requirements - Part 3.10.1.0 (f)

The ShedSafe™ shed accreditation scheme was developed by The Australian Steel Institute for the steel shed industry.

ShedSafe sets the standard for steel sheds.

The logo guarantees that the company providing the design has completed an independent, third-party review of engineering principles and design documentation.

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