MONIER™

Top Cat in Roofing

DESIGN GUIDE

The design of a tiled roof and its supporting structure requires careful consideration, involving understanding of a number of building standards.

One of the key responsibilities of the specifier is to determine the design gust wind speed affecting a particular site.

MONIER

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DESIGN CONSIDERATIONS

To facilitate this, the Australian Standards AS 1170.2, AS 4055 and NZS 4203 are to be considered, regarding:

- The regional design wind speeds
- The terrain category of a building site
- The Technical Record 440 (TR440) extension of this code, which is deemed to be the standard for design of products for most cyclonic areas
  This is particularly applicable in Australia to areas north of the latitude 250 south, and within 50kms of the coast (including off shore islands).
- **Local requirements and covenants determined by State and/or local statutory authorities. Special conditions may apply to the site in relation to items a), b) and c)**

The installation specifications given in this manual are based on a basic wind speed for ultimate strength of 74m/s at a height of 6m from ground level. This is suitable for sites in Regions A, B and New Zealand. For installation specifications for designated cyclonic areas i.e. Regions C and D it is also advisable to consult both your building engineer and your local Monier Roofing office.

This section will cover Monier Roofing's recommended installing specifications based on the design gust wind speed, as well as:

- Minimum roof pitch requirements
- Maximum rafter length requirements
- Rafter and truss spacings and batten requirements
- Batten installing requirements
- Sarking/underlay installation requirements

Please note that relevant local authorities may apply special specification to the final structure. Specifiers are advised to determine local requirements before proceeding.

Furthermore, regional Monier Roofing offices may recommend additional installing specifications based on experience of a particular region, so it is also advisable to consult your local Monier Roofing office prior to commencement of work.

WIND CATEGORIES

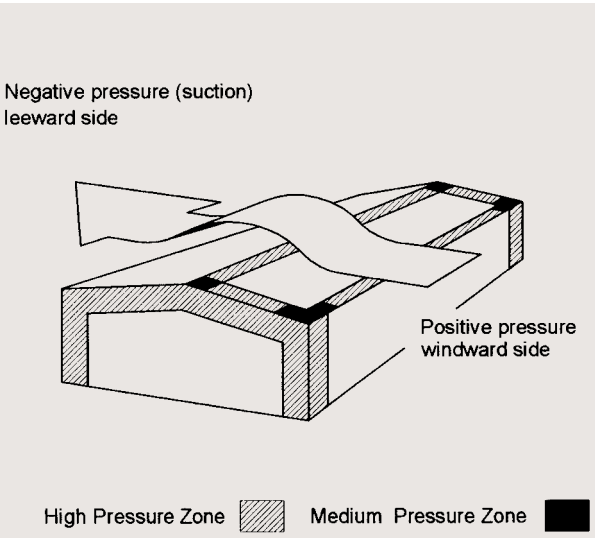
Winds and the pressure they create, must be considered when specifying roof structures and roofing materials.
The negative pressure exerted to the leeward side of a pitched roof at 35m/s can be greater than the weight of the tiles, therefore determining the wind force affecting a site at height is essential to identify the appropriate level of security installation.

The magnitude of these wind forces is affected by the following factors:
Basic wind speed, Direction, Terrain and Building height.

BASIC WIND SPEED CATEGORIES

AS 1170.2/Amdt 3 and AS 4055 provides information on wind speeds generally affecting different regions of Australia.

NEGATIVE PRESSURE (SUCTION) LEEWARD SIDE

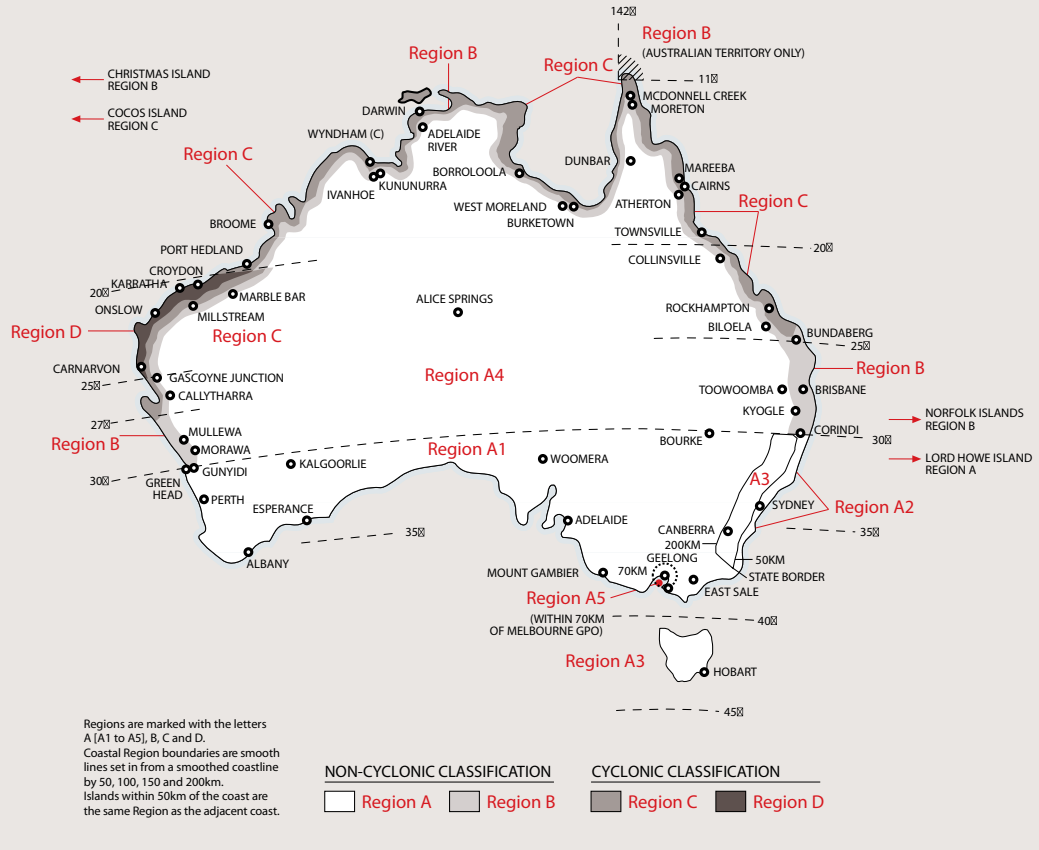


REGIONS	V_s (M/S)
A	38
B	38
C	45
D	50

REGIONS	V_p (M/S)
A	41
B	49
C	57
D	69

REGIONS	V_u (M/S)
A	50
B	60
C	70
D	85

AUSTRALIA



NEW ZEALAND

LEE MULTIPLIER, M_{lea}

SOUTH EAST WIND	NORTH WEST WIND
Shadow zone: 0–12km	Shadow zone: 0–12km
Outer zone: 12–30km	Outer zone: 12–30km

Distances measured in the down wind direction of the wind from the initiating ridge.

*** NZS 4203 General Structual Design and Design Loading for Buildings provides information on wind speeds generally affecting different regions of New Zealand.**

For further information on Wind Loads in New Zealand refer to NZS 4203 General Structual Design and Design Loading for Buildings.

Based on the Wind Class specification provided, Monier Roofing is able to assess the appropriate level of security installation required for the roof in accordance with AS 2050 Installation of Roof Tiles.

It is the specifiers responsibility to determine the wind speed affecting a site and a house design. In other words to determine the Wind Class of a regional area combined with the Wind Speeds affecting a site. Cyclone affected regions will have a Wind Class from C1 to C4. For non-cyclonic regions, a Wind Class from N1 to usually N4 is required to be specified on your roofing structure plan.

The table below summarises the relationship between the Wind Speeds and the Wind Class.

TABLE 1: DESIGN WIND SPEED — EQUIVALENT VALUES/AS 4055

WIND CATEGORY	KM/H	FOR NON-CYCLONIC REGIONS A AND B	FOR CYCLONIC REGIONS C AND D	DESIGN GUST WIND SPEED (M/SEC) ▲ PERMISSIBLE STRESS METHOD ONLY
W28	101	N1	•	28
W33	119	N2	•	33
W41	148	N3	C1	41
W50	180	N4	C2	50
W60	216	N5	C3	60
W70	252	N6	C4	70

Wind Classification system N1, N2, N3, N4, N5, N6 for non-cyclonic Regions A and B, and C1, C2, C3 and C4 for cyclonic Regions C and D shall be considered. The system includes the combinations of regions, terrain categories, shielding of housing and topographic effects given in Table 2.

TABLE 2: WIND CLASSIFICATION SYSTEM (REFER AS 4055)

REGION	TERRAIN CATEGORY	TOPOGRAPHIC CLASSIFICATION														
		T1			T2			T3			T4			T5		
		FS	PS	NS	FS	PS	NS	FS	PS	NS	FS	PS	NS	FS	PS	NS
A	TC 3	N1	N1	N1	N2	N2	N2	N2	N3	N3	N2	N3	N3	N3	N3	N4
	TC 2.5	N1	N1	N2	N2	N3	N3	N2	N3	N3	N3	N3	N4	N3	N4	N4
	TC 2	N1	N2	N2	N2	N3	N3	N3	N3	N3	N3	N4	N4	N4	N4	N4
	TC 1	N2	N3	N3	N3	N3	N4	N3	N4	N4	N4	N4	N4	N4	N5	N5
B	TC 3	N2	N2	N3	N3	N3	N4	N3	N4	N4	N4	N4	N4	N4	N5	N5
	TC 2.5	N2	N3	N3	N3	N4	N4	N3	N4	N4	N4	N4	N5	N4	N5	N5
	TC 2	N2	N3	N3	N3	N4	N4	N4	N4	N5	N4	N5	N5	N5	N5	N6
	TC 1	N3	N4	N4	N4	N5	N5	N4	N5	N5	N5	N5	N6	N5	N6	N6
C	TC 3	C1	C1	C2	C2	C2	C3	C2	C3	C3	C3	C3	C3	C3	C4	C4
	TC 2.5	C1	C2	C2	C2	C3	C3	C3	C3	C3	C3	C4	C4	C4	C4	NA
	TC 1, TC 2	C2	C2	C2	C2	C3	C3	C3	C4	C4	C3	C4	C4	C4	NA	NA
D	TC 3	C2	C3	C3	C3	C4	C4	C3	C4	C4	C4	NA	NA	NA	NA	NA
	TC 2.5	C2	C3	C3	C3	C4	C4	C4	NA	NA	C4	NA	NA	NA	NA	NA
	TC 1, TC 2	C3	C3	C4	C4	NA	NA	C4	NA	NA	NA	NA	NA	NA	NA	NA

FS full shielding
NS no shielding
C cyclonic
PS partial shielding
N non-cyclonic
N/A not applicable

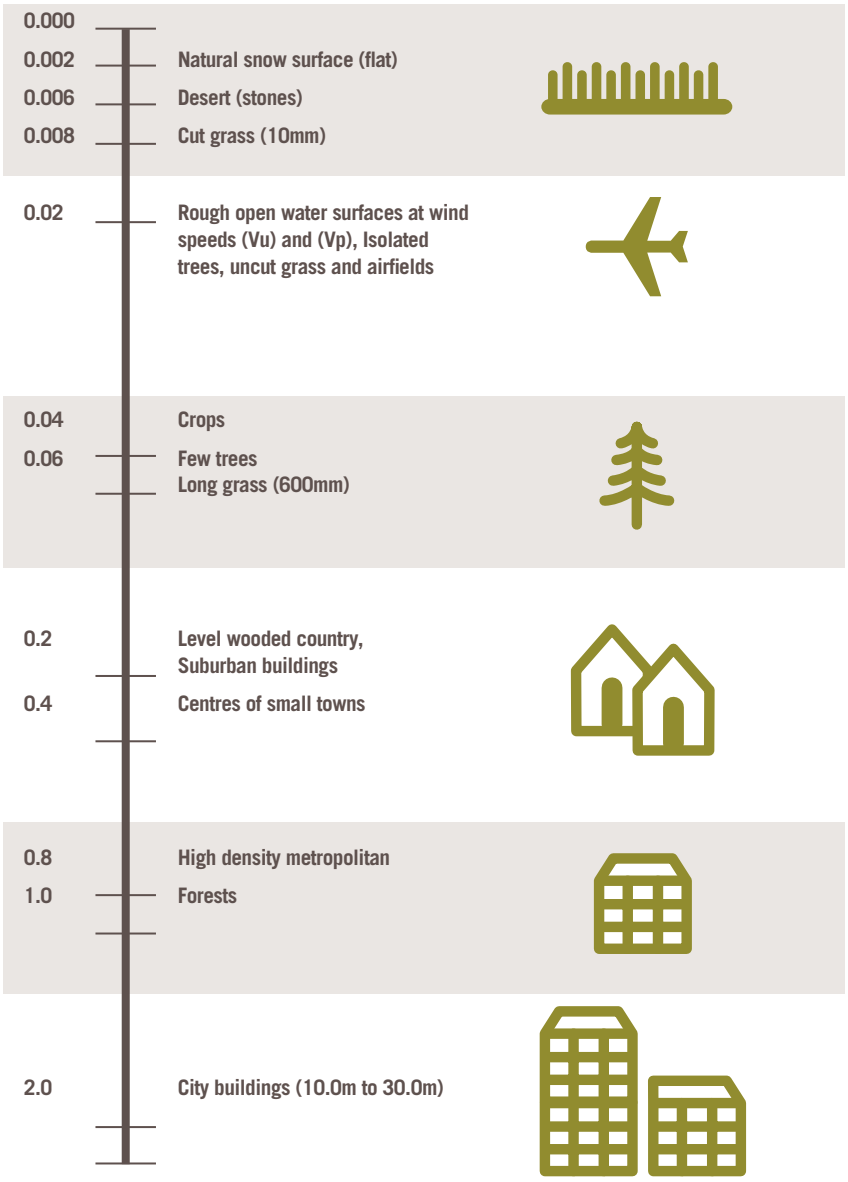
TERRAIN CATEGORIES

TERRAIN

The shielding provided by permanent structures, hills and vegetation has the effect of modifying wind speeds.

Terrain categories are used for determining a site's exposure to wind. In Australia, terrain is defined in accordance with AS 1170.2 and AS 4055 into four categories. In NZ, the relevant standard is NZS 4203. For the effective use of this tool, the direction and speed of wind flows towards a site must be assessed.

ROUGHNESS LENGTH (2°)M



THE FOUR TERRAIN CATEGORIES ARE:

Terrain Category 1
$Z^{\circ} = 0.002M$

Exposed open terrain with few or no obstructions, in which the average height of objects surrounding the structure is less than 1.5 metres. This category includes water surfaces (open sea coast and lakes), flat and treeless plains, and open snowfields.

Terrain Category 2
$Z^{\circ} = 0.02M$

Open terrain, grassland with few well-scattered obstructions having heights generally from 1.5 to 10.0 metres. This category includes open parkland and sparsely built up outskirts of towns and suburbs.

Terrain Category 3
$Z^{\circ} = 0.2M$

Terrain with numerous closely spaced obstructions having the size of domestic houses. This includes most suburban areas.

Terrain Category 4
$Z^{\circ} = 2.0M$

Terrain with numerous large, high (10.0 to 30.0 metres) and close obstructions, such as large city centres and well-developed industrial complexes.

FIXING REQUIREMENTS FOR TILES AND ACCESSORIES

TABLE 3: AS2050 MINIMUM MECHANICAL INSTALLING REQUIREMENTS FOR TILES AND ANCILLARIES

WIND CLASSIFICATION	TILE INSTALLING		ANCILLARY INSTALLING
	EDGE OF ROOF	FIELD OF ROOF	RIDGE, HIP AND BARGE TILES
Up to and including N2 N1 and N2	Mechanically fasten each full tile in second course and then every second tiles in every course or every tile in each alternate course		Mechanically fasten each tile
Up to and including N3 and C1	Mechanically fasten each full tile in second course	Mechanically fasten each second full tile	Mechanically fasten each tile
N4 and C1/C3	Mechanically fasten every full tile	Mechanically fasten every full tile	Mechanically fasten each tile

TABLE 4: AS 2050 WIND CLASSIFICATION AND MAXIMUM DESIGN GUST WIND SPEED

WIND CLASSIFICATION	MAXIMUM DESIGN GUST WIND SPEED (M/S)		
	PERMISSABLE STRESS METHOD (VP)	SERVICEABILITY LIMIT STATE (VS)	ULTIMATE LIMIT STATE (VU)
N1	28 (W28N)	26	34
N2	33 (W33N)	26	40
N3C1	41 (W41N/C)	32	50
N4C2	50 (W50N/C)	39	61
C3	60 (W60C)	47	74

Note: Wind classifications are as defined in AS 4055

TABLE 5: AUSTRALIAN MECHANICAL REQUIREMENTS FOR TILES AND ACCESSORIES

DESIGN WIND VELOCITY (M/S)	TILE FIXING		RIDGE FIXING		BARGE FIXING
	EDGE OF ROOF	FIELD OF ROOF	RIDGE TILES	HIP RIDGE TILES	
Up to but not including ≤ 33	Mechanically fix all full tiles in the 2nd course and then either every 2nd tile in every course, or every tile in every 2nd course		Mechanically fix every ridge tile.	Mechanically fix every ridge tile.	Mechanically fix each barge tile.
≥ 34 < 41	Mechanically fix each full tile in 2nd course	Mechanically fix each 2nd full tile	Mechanically fix every ridge tile	Mechanically fix the end four hip ridge tiles.	Mechanically fix each barge tile.
≥ 41 < 60	Mechanically fix every full tile	Mechanically fix every full tile	Mechanically fix every ridge tile	Mechanically fix every hip ridge tiles.	Mechanically fix each barge tile.

TABLE 6: NEW ZEALAND MINIMUM FIXING REQUIREMENTS FOR TILES AND ACCESSORIES

DESIGN WIND VELOCITY (M/S)	TILE FIXING EDGE OF ROOF/BODY OF ROOF	RIDGE & HIP FIXING	BARGE FIXING
LOW WIND SPEED Up to 32 m/s	Mechanically fix all full tiles in 2nd course and then either every 2nd tile in every course, or every tile in every 2nd course	Approved adhesive or mechanical fastening of ridge and hip capping	Mechanically fix each barge tile
MEDIUM WIND SPEED Up to 37 m/s	Mechanically fix all full tiles in 2nd course and then either every 2nd tile in every course, or every tile in every 2nd course	Approved adhesive or mechanical fastening of ridge and hip capping	Mechanically fix each barge tile
HIGH WIND SPEED UP TO 44 M/S*	Mechanically fix all full tiles in 2nd course and then either every 2nd tile in every course, or every tile in every 2nd course	Approved adhesive or mechanical fastening of ridge and hip capping	Mechanically fix each barge tile
VERY HIGH / EXTRA HIGH WIND SPEED Up to 74 m/s*	Mechanically fix every full tile	Approved adhesive or mechanical fastening of ridge and hip capping	Mechanically fix each barge tile
SPECIFIC ENGINEERING DESIGN Over 74 m/s*	Please consult your Regional Monier Roofing Office	Please consult your Regional Monier Roofing Office	Please consult your Regional Monier Roofing Office

Note:

- Accepted methods of mechanical fixing are specified later in this manual.
- Monier Roofing recommends the use of Flexible Pointing as standard for all roofs, removing the need for other forms of mechanical fixing. Flexible Pointing also provides other significant benefits referred to later in this manual.
- Please consult your regional Monier Roofing office for their specific recommendations.

*Require roofing underlay.

TABLE 7: AUSTRALIAN FIXING RECOMMENDATIONS

WIND CLASS	SARKING/ UNDERLAY	SECURITY PADS	MECHANICALLY FIX TILES	MECHANICALLY FIX EAVE TILES	ANTI-PONDING BOARD	FIXING BODY AND EDGE OF ROOF
N1	Optional depending on pitch	Optional	Optional	Optional	Required for pitches under 20° subject to state specifications	See table 3
N2		Recommended				
N3	Mandatory as specified by AS 4200.2					
N4			Mandatory	Recommended		
C1						
C2						
C3						

TABLE 8: NEW ZEALAND FIXING RECOMMENDATIONS

WIND CLASS	UNDERLAY	MECHANICALLY FIX TILES	MECHANICALLY FIX EAVE TILES	ANTI-PONDING BOARD	FIXING BODY & EDGE OF ROOF
Low	Hacienda: Optional depending on pitch Other Profiles: Mandatory			Required for pitches under 17^0	See Table 6
Medium	Hacienda: Optional depending on pitch Other Profiles: Mandatory			Required for pitches under 17^0	See Table 6
High	Mandatory			Required for pitches under 17^0	See Table 6
Very High / Extra High	Mandatory	•	•	Required for pitches under 17^0	See Table 6

• Denotes recommendation

MINIMUM ROOF PITCH

Monier Roofing tiles are designed and tested to cope with the diverse range of wind and weather conditions across Australia and New Zealand.

The following factors affect the design of your roof:

THE ROOF TILE SELECTION

With a profiled roof tile, the depressions in the body of the tile act as a natural watercourse, enabling water to be channelled down the roof quickly.

For flatter profiled tiles, these depressions are either less prominent or do not feature. As a result, water is freer to be pushed across the roof surface by wind. The effect is that water migrates to the watercourse of the tile.

THE PITCH OF THE ROOF

The greater the pitch, the greater the force of gravity combined with wind force to pull water from the roof.

Conversely, the lesser the pitch, the lesser the force of gravity combined with wind force to pull water from the roof.

For this reason, tiling is not recommended below 15 degrees without special precautions being taken in direct consultation with your regional Monier Roofing office.

UNDERLAY

Sarking/underlay is a pliable foil installed prior to fixing the roof battens.
In New Zealand underlay is a self supporting building paper. Not only does sarking/underlay act as a secondary water catchment, sarking/underlay also aids with keeping your home cooler and dust free.

There are several differing grades of sarking/underlay, it is recommended that you consult with your local Monier Roofing representative who can assist you with the correct application to suit your particular design.

Where Hacienda tiles are being fixed without underlay in a Low or Medium Wind Class, underlay must still be used for any roof receiving discharge from a spreader.

Table 9 indicates the minimum roof pitch at which Monier Roofing tiles are to be installed, with and without the need for sarking/underlay, for each region.

TABLE 9: MINIMUM ROOF PITCH — DEGREES

MINIMUM PITCH	NZ		NSW		VIC		QLD		SA		WA		CYCLONE AREA	
MONIER CONCRETE	Without Underlay	With Underlay	Without Underlay	With Underlay	Without Underlay	With Underlay	Without Underlay	With Underlay	Without Underlay	With Underlay	Without Underlay	With Underlay	Without Underlay	With Underlay
Hacienda	20	15	na	na	na	na	na	na	na	na	na	na	na	na
Horizon	#	20*	20	15*	20	15*	20	15*	20	15*	25	22.5	#	25
Georgian	#	20*	20	15*	20	15*	20	15*	20	15*	25	22.5	#	25
Madison	#	20*	20	15*	20	15*	20	15*	20	15*	25	22.5	#	25
TERRACOTTA														
Nouveau	#	20	20	15	20	15	20	15	20	15	20	15	#	18.5
Marseille	#	20	20	15	20	15	20	15	20	15	na	na	#	17.5
Portugese	#	25	na	na	na	na	na	na	na	na	na	na	na	na

\# Underlay required regardless of pitch
Anti ponding boards are required for pitches less than 17 degrees and in cyclone areas
Consideration must be given to rafter length, site exposure and terrain category when determining roof pitch

* Refer to EDGE technology fixing specification

na not available

Where Hacienda tiles are being fixed without underlay in a Low or Medium Wind Class, underlay must still be used for any roof receiving discharge from a spreader.

EDGE TECHNOLOGY FIXING SPECIFICATION

MONIER™ ROOF TILES TREATED WITH 'EDGE' TECHNOLOGY

'EDGE' TECHNOLOGY

Monier's breakthrough 'EDGE' Technology is a patented process that now offers architects and designers greater flexibility when it comes to contemporary roof design.
'EDGE' technology has been comprehensively field tested, and has also undergone rigorous wind tunnel testing to ensure product performance exceeds AS 2050-2002.
Additionally, successful testing has also been conducted at Lafarge's world class testing facility in London England.

PRODUCT SPECIFICATION

This fixing specification is to be used when installing Monier roof tiles that have been treated with Monier's Patented 'EDGE' technology.

PRODUCT RANGE

Horizon, Georgian, Madison

UNDERLAY

Mandatory for all pitches.
Additional consideration must be given to locations that are elevated, or in coastal regions which are exposed to high / very high / extra high wind speeds.

MINIMUM ROOF PITCH

20 degrees with underlay.
At the minimum roof pitch of 20 degrees, the maximum rafter length is 4.5 metres.
For longer rafter lengths add 2 degrees to the pitch for every additional metre.

HEAD LAP

Minimum Head lap is 100mm.
This may increase according to setout, however head lap should not exceed 110mm

FIXING

Nailing is required for wind speeds up to N2.
Cyclone clips are required for wind speeds of N3 or more.

GENERAL

Special Consideration should be given to regions prone to cyclonic activity. Alternate fixing methods may need to be adopted.
Refer these enquiries to the technical support team.

RAFTER LENGTH AND SPACINGS

RAFTER LENGTH

With heavy rainfall, a considerable volume of water can accumulate at the bottom of a roof. The longer the roof run (rafter length), the more water accumulates.

AS 2050 states long rafter lengths may require sarking/underlay to prevent inundation of water into the roof. These lengths may vary according to the tile, the pitch of the roof and the exposure.

Monier Roofing advises against the use of minimum pitch for long rafter lengths without sarking/underlay.

As a general guide for contoured tiles, rafter length should not exceed 4.5m at a minimum pitch of 15 degrees.
For every 0.5m increase in rafter length above 4.5 metres, the pitch should increase by 1 degree until the acceptable pitch of 22.5 degrees is reached for long rafters.

Table 10 indicates the rafter length dimensions at which sarking/underlay should be installed over the whole roof. Advice should be sought from your local Monier Roofing office with regard to regional sarking/underlay installation requirements.

RAFTER (TRUSS) SPACINGS

The wider the rafter spacing, the greater the stresses upon them, and the batten specified.

Battens made of timber should be sound, and in sufficient length and size to meet regional fixing requirements. Batten sizes and types vary by region, however must be fixed in accordance with the AS 1684 or AS 1720.1 and NZS 3604 in New Zealand.

RAFTER LENGTH CONSIDERATIONS

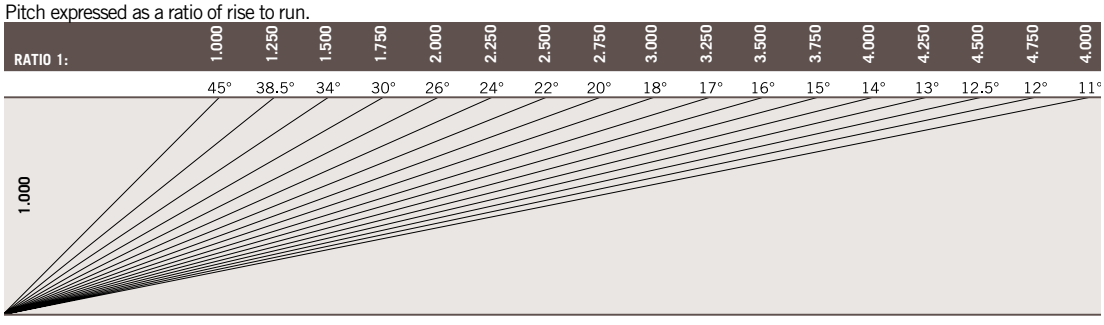
Monier Roofing tiles are designed to be dimensionally consistent, allowing some tolerance to assist the roof tiler during set out. However, it is advisable to consider the rafter length at the design stage, to avoid the need to cut a short tile course.

TABLE 10: PITCH LEVELS IN RELATION TO RAFTER LENGTH

Hacienda Profile - With Underlay		Hacienda Profile - Without Underlay		Horizon, Georgian, Madison, Nouveau and Marseille Profiles - With Underlay		Portuguese Profile - With Underlay	
Maximum Rafter Length (mm)	Roof Degrees Of Pitch	Maximum Rafter Length (mm)	Roof Degrees Of Pitch	Maximum Rafter Length (mm)	Roof Degrees Of Pitch	Maximum Rafter Length (mm)	Roof Degrees Of Pitch
4500	15	4500	20	4500	20	4500	25
5000	16	5000	21	5000	21	5000	26
5500	17	5500	22	5500	22	5500	27
6000	18	6000	23	6000	23	6000	28
6500	19	6500	24	6500	24	6500	29
7000	20	7000	25	7000	25	7000	30
7500	21	7500	26	7500	26	7500	31
8000	22	8000	27	8000	27	8000	32
8500	23	8500	28	8500	28	8500	33
9000	24	9000	29	9000	29	9000	34
9500	25	9500	30	9500	30	9500	35
10000	26	10000	31	10000	31	10000	36

RISE AND RUN CHART

Pitch expressed as a ratio of rise to run.



Equivalent pitch in degrees is a close approximation only

BATTEN SIZES AND RAFTER SPACINGS

The following table summarises suitable batten types at varying rafter spacings, with the current Monier Roofing practice in each region.

TABLE 11: BATTEN SIZES AND RAFTER SPACINGS (MM)

BATTEN MATERIAL SPECIFICATION				
RAFTER SPACING	UP TO 450	451▲ 600	601▲ 900	901▲ 1200
New South Wales	Hardwood 38 x 25	Hardwood 25 x 50	Hardwood 38 x 50	Metal Topspan 40
	Softwood 38 x 28	Softwood 38 x 38	Softwood 50 x 50	
			Softwood 63 x 38	
			Metal Topspan 40	
Victoria	Hardwood 38 x 25	Hardwood 25 x 50	Hardwood 38 x 50/38 x 38	Hardwood 38 x 75
	Softwood 38 x 28	Softwood 38 x 38	Softwood 50 x 50	Metal Topspan 40
		Metal Topspan 40	Metal Topspan 40	
Queensland	Hardwood 38 x 25	Hardwood 25 x 50	Hardwood 38 x 50	Hardwood 50 x 50
		Softwood 38 x 38	Softwood 40 x 50	Metal Topspan 40
			Metal Topspan 40	
South Australia	Hardwood 38 x 25	Hardwood 25 x 38	Hardwood 38 x 50	Hardwood 50 x 75
		Metal Topspan 40	Softwood 50 x 50	Metal Topspan 40
			Metal Topspan 40	
Western Australia	Hardwood 38 x 25	Hardwood 38 x 25	Hardwood 38 x 38	Hardwood 50 x 50
		Softwood 38 x 38	Softwood 63 x 38	
		Metal Topspan 40	Metal Topspan 40	Metal Topspan40
Tasmania	Hardwood 38 x 25	Hardwood 25 x 50	Hardwood 38 x 50	Hardwood 50 x 75
		Softwood 38 x 38	Softwood 50 x 50	Metal Topspan 40
		Metal Topspan 40	Metal Topspan 40	
Australian Capital Territory	Hardwood 38 x 25	Hardwood 25 x 50	Hardwood 38 x 50	Hardwood 50 x 50
		Softwood 38 x 38	Softwood 63 x 38	Metal Topspan 40
			Metal Topspan 40	
New Zealand	Softwood 25 x 50	Softwood 40 x 50	Softwood 50 x 50	Softwood 50 x 75*
		Metal Topspan 40	Metal Topspan 40	Metal Topspan 40*

Green font denotes the recommended and commonly used batten specification in each region.

* With engineer approval

Where metal battens are used refer to the batten supplier's fixing specification.