

DOMESTIC DECK DESIGN GUIDE



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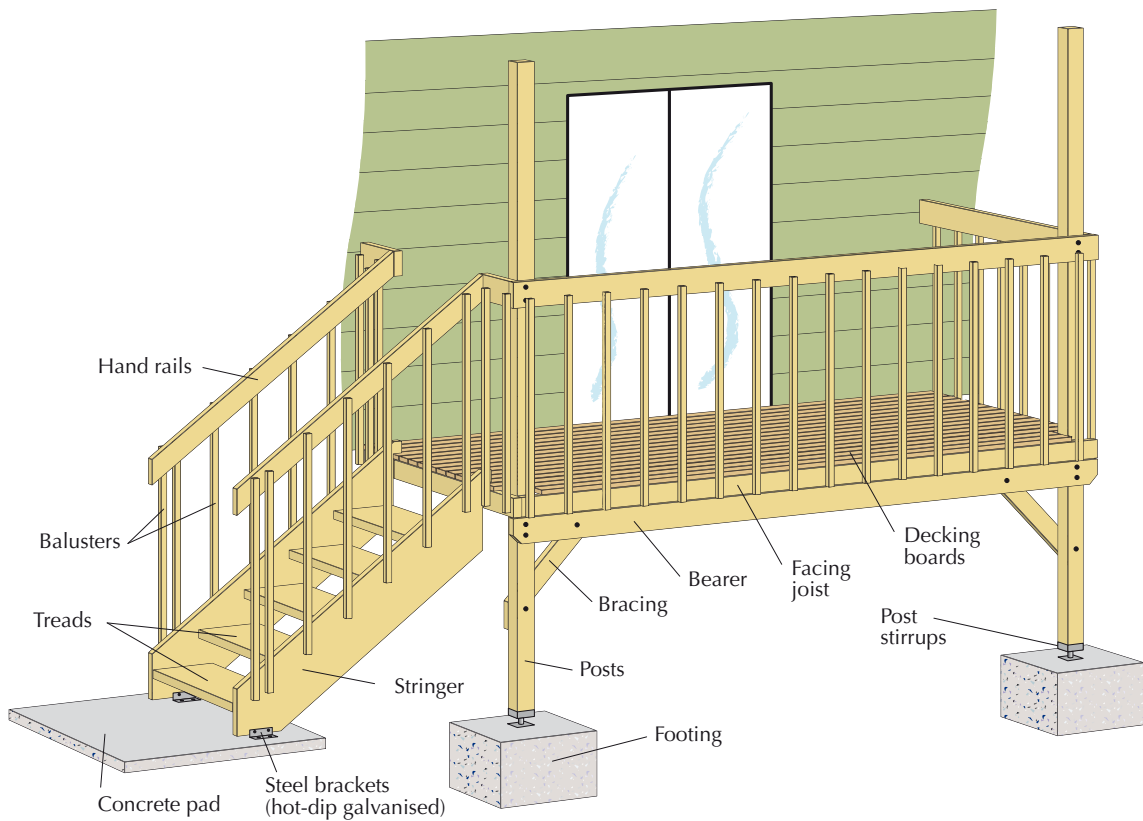
SCOPE

This guide outlines key design and construction considerations for light domestic timber decks for both raised and close to or on-ground timber decks that are exposed to the weather.

It covers decks that are associated with Class 1 (detached houses, villas, townhouses etc) and Class 10 (garages, sheds, swimming pools etc) structures according to the National Construction Code (NCC). For the design and construction of decks for commercial, industrial or marine applications or where a deck has to take heavier loads such as tiles, spas or even vehicles, a structural engineer will have to be consulted.

Terminology used in domestic deck design and construction are illustrated in Figure 1.

Figure 1: Components used to make up a timber deck



Front Cover Image
Project: Castlecrag Residence
Architects: CplusC Architectural Workshop
Photographer: Murray Fredericks

HOW TO USE THIS GUIDE

Section A of this guide provides general information applicable to all types of light domestic decks. Information relevant to specific types of decks is contained in Section B.

SECTION A - GENERAL INFORMATION

The following information is applicable to all deck systems.

BEARERS AND JOISTS

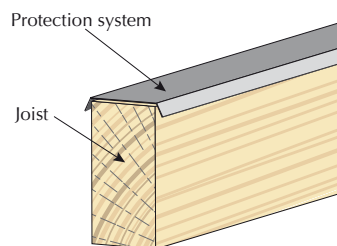
Bearers and joists come in a variety of sizes, timber types and stress grades and their availability will vary from one region to the next.

Generally speaking the available stress grades in unseasoned hardwood are F11 and F14 whilst seasoned hardwoods are available in F17 or F27 stress grades. Treated softwoods are predominately available in F7 stress grade however F5 and MGP10 are available in some regions.

The correct bearer sizes can be found in span Table 49 in AS1684. These tables assume a minimum end bearing of 50 mm by bearer width, and intermediate bearing of 100 mm by bearer width for continuous bearers. Joists that are at least 45 mm wide (seasoned hardwood and treated softwood) or 50 mm wide (unseasoned hardwood) are recommended in order to avoid splitting when receiving nails or screws from placement of decking boards. This is particularly relevant where decking boards abut over the joist as the fixings can be placed further from the board's end. Joist sizes can be found in the span Tables 50 in AS1684. Joists of 35 mm or 38 mm width are only suitable where proprietary deck fixings are used which are fixed to the side of joists.

Placing a layer of 110 mm malthoid dampcourse or proprietary protection system on top of the joists will increase the service life of the joist, refer Figure 2.

Figure 2: Protection strip over deck joists



Note that the recommended timber sizes for the bearer and joist are for where decking boards only are being used. Where tiles are used as a deck covering, the sizes in AS1684 are not applicable. In this circumstance advice should be sought from an engineer.

STRUCTURAL JOINTS AND CONNECTIONS

The joints between posts, bearers and joists need to be able to transfer load efficiently through the structure, refer to AS1684 for design of these elements.

All connections should be of sufficient durability. All framing bolts, screws, nails, and other hardware should be hot dipped galvanised, plastic coated or stainless steel. Electroplated fasteners are not suitable due to early breakdown of the plating. Fixings within the splash zones (minimum 1.0 m from pool edge) of swimming pools must be stainless steel.

Fixings for preservative treated decking boards should be hot dipped galvanised, stainless steel or with a coating approved for use on decking boards.

Timber washers need to be appropriately sized, refer to Table 1.

Table 1: Timber washer selection guide for coach screws or bolts

Bolt	Washer size		
	Thickness (mm)	Round Washer Minimum Dia. (mm)	Square Washer Min.Side Length (mm)
M8	2.0	36	36
M10	2.5	45	45
M12	3.0	55	55
M16	4.0	65	65
M20	5.0	75	75

Note: Source AS1720.1

Due to moisture potentially being trapped at the interface of a bearer and post connection a timber sealer should be used between the interfacing elements.

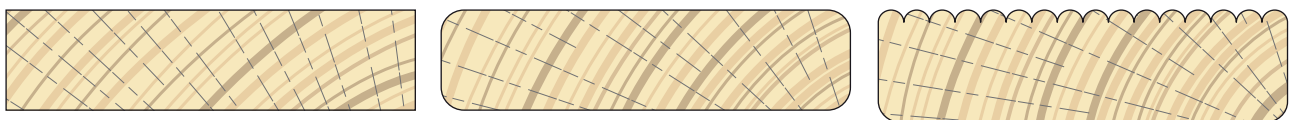
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DECKING BOARDS

There are three main types of decking board profiles available; plain, pencil round and ribbed, refer Figure 3.

Plain profile is not common as the square edges of the boards are more prone to splintering. Pencil Round has significantly less chance of splintering compared to plain boards. Ribbed board profile can be used faced up or down. Ribbed facing down provides maximum surface area for grip however care should be taken in moist areas that the boards are kept free of mould and moss build up which can make the boards slippery.

Figure 3: Common decking board profiles



Plain Profile

Pencil Round Profile

Reeded Profile

Decking boards are also available in various widths. In all cases it is recommended that boards with a narrow width are selected because it is easier for water to drain through the deck. Where wider boards are selected they will need to be thicker to reduce the possibility of cupping developing.

Tongue and grooved timber, plywood or particleboard sheet flooring products are not recommended for use as decking in weather exposed situations.

SPAN CAPACITY

Various timber decking boards have different span capacity. Table 2 gives maximum span of the common decking board timbers and thicknesses.

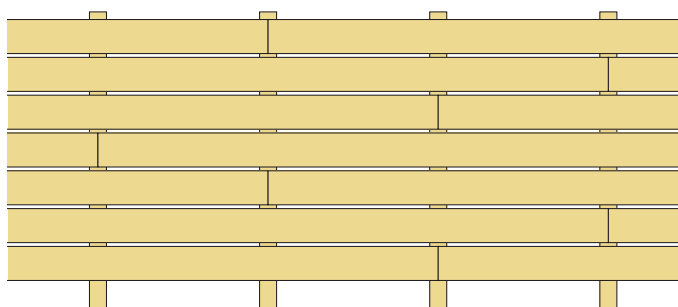
Table 2 Maximum joist spacing for various decking boards

Decking	Stress Grade	Thickness (mm)	Maximum joist spacing (mm)
Hardwood	Standard Grade (AS 2796.1)	19	500
Cypress	Grade 1 (AS 1810)	19	400
		21	450
Treated Softwood	Standard grade (AS 4785.1)	19	400
		22	450

Source: AS1684

Decking boards must be supported over at least three joists and butt joints in boards should be staggered. Refer to Figure 4.

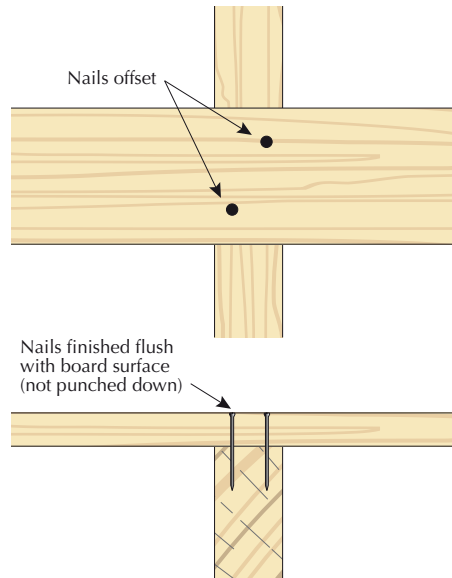
Figure 4: Illustration of staggered decking boards



NAIL FIXING

Each board must be fixed at each joist with at least two nails which should be finished flush with the top of the boards (rather than punched) to prevent moisture being trapped. Where the fixing occur other than at the ends of the board, nails should be staggered across the joist to avoid cracks caused by moisture movement in the decking, refer Figure 5.

Figure 5: Illustration of nail fixing timber decking



To obtain a tight fit at joints for abutting boards, a slight under-cut is recommended, refer Figure 6. To reduce the splitting of the decking board, nails or screws must be kept a minimum of 12 mm from edges and the boards end. The drilled nail holes should be 80% of the nail diameter.

Figure 6: Nailing at board ends

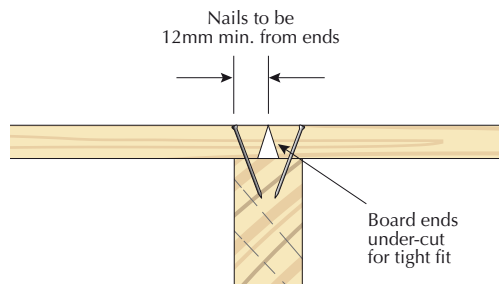


Table 3 describes the minimum nails that can be used for decking up to 22mm thick and the deck joists.

Table 3: Minimum nail size for various timber species decking and joist combinations

Decking	Joists	Nailing 2 nails per board crossing			
		Machine driven		Hand driven	
Hardwood or cypress	Hardwood or cypress	50 x 2.5 flat or dome-head		50 x 2.8 bullet-head	
	Treated softwood	50 x 2.5 flat-head deformed shank	65 x 2.5 flat-head or dome-head	50 x 2.8 bullet-head deformed shank	65 x 2.8 bullet-head
Treated softwood	Hardwood or cypress	50 x 2.5 flat or dome-head		50 x 2.8 flat or dome-head	
	Treated softwood	50 x 2.5 flat-head deformed shank	65 x 2.5 flat-head	50 x 2.8 flat head deformed shank	65 x 2.8 flat-head

MACHINE DRIVEN NAILS

Generally machine driven nails are proprietary to the nailing gun manufacturer and are not referenced in AS1684. Machine driven nails can be used as long as the nail has the same capacity as the hand driven nails detailed in Table 3. T-nails should not be used. Care is also required in using machine driven nails to ensure that the top of the nail head is not driven below the surface of the board.

SCREW FIXING

Like machine driven nails, screw requirements are not referenced in AS1684. The principles described above for nails should be followed for screw fixings. Types of screws are generally proprietary and reference to the manufacturer specification is required.

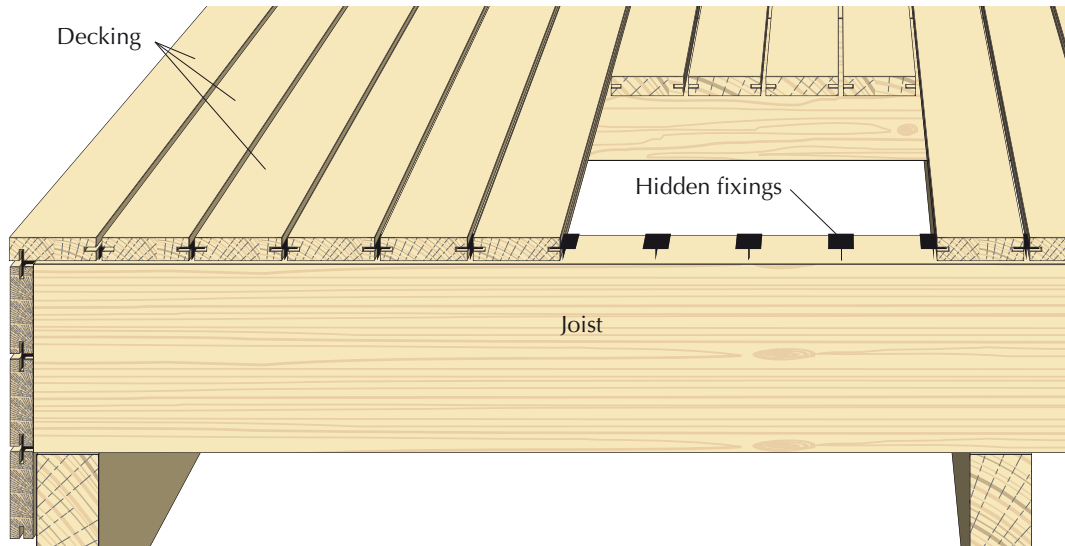
FIXINGS TO STEEL JOISTS

Screws used normally for timber decks are not suitable for fixing decking to steel joist due to the seasonal and differential expansion and contraction of timber decking and steel substructure may cause the screws to fail in shear. It is recommended that a timber batten is affixed above or beside the steel joist so the decking boards is nailed or screwed to this batten. Size of timber batten is to allow adequate fixing for the decking to batten as well as the batten to the steel joist.

HIDDEN FIXINGS

There are a number of proprietary systems available that fix the decking at the side of the board, refer Figure 7. Most systems require a groove into the side of the decking for fixings whilst some use spikes. In all cases the fixing systems are proprietary and manufacturers' recommendation must be followed.

Figure 7: Hidden timber deck fixings



FINISHING

As a minimum, a protective finish should be applied to all surfaces (including any freshly cut ends) of each decking board, preferably before fixing to the joists. A protective finish includes products which penetrate the surface of the timber and products which provide a film or coating to the surface of the timber.

This protective finish of the timber surface will reduce the effects of weathering of any timber (treated or untreated) in an exposed situation. From a durability perspective the main function of the finish is to slow down the rate at which the timber will take up or lose moisture. By slowing that rate down, the severity of any checking is considerably reduced. The finish should contain a fungicide to prevent mould growing on any sugars or starches that may be in the finish.

Further information can be found in WoodSolutions' Guide No 13 – Finishing Timber Externally.

TIMBER DURABILITY

The recommended durability of the timber for deck sub-structure and decking boards are contained in Section B of this guide. In all cases either a recommended natural durability class or preservative treated timber hazard level are given.

NATURAL DURABILITY CLASSES

There are two natural durability classes used in this guide “above-ground (AG) and “in-ground (IG)”. A number of Australian Standards list the above-ground and in-ground durability class for various timbers. These Standards are -

- *AS1684 Parts 2 and 3 Residential timber-framed construction,*
- *AS5604 Timber—Natural durability ratings*

Other sources of information on timber durability can be found in:-

- *Keith Bootle’s Wood in Australia*
- *WoodSolutions Technical Guide #5 Timber Service Life Design – Design Guide for Durability*

The durability class of many imported timbers can also be found in the Australian Standards referenced above. Where there is no durability class given for a timber species an indicator of performance can be found for a number of timber species from the paper; Natural Durability of Wood: A Worldwide Checklist of Species, Scheffer and Morrell 1998. In this publication the offered durability classes do not correspond with Australia’s system but it does indicate better performing species.

PRESERVATIVE TREATED TIMBER HAZARD LEVELS

Australian Standard *AS 1604 Timber - Preservative-treated - Sawn and round* define the retention rates for various timber preservatives for various exposures and hazard levels.

Note that timber treated with the preservative Copper Chrome Arsenate (CCA) is not allowed to be used in areas where children could come into frequent or intimate contact with it. That is handrail or decking boards. CCA treated timber is still OK to be used in other locations of the deck such as framing, balustrades, posts and so on. Timber treated with other preservatives such as ACQ (alkaline copper quatarnary), copper azole or LOSP (light organic solvent preservatives) are OK to be used as handrails and decking boards. Note that timber treated with LOSPs is not suitable for in-ground use.

BUSHFIRE CONSTRUCTION REQUIREMENTS

In all parts of Australia that are prone to bushfires there are limitations on the use of timber in deck construction. This limitation varies depending on the risk of bushfire attack and the elements of the deck under consideration.

Appendix A of this guide contains a list of common timber species used for timber decks and the maximum Bushfire Attack Level (BAL) that the species can be used in a deck, in accordance with *AS 3959 Construction of buildings in bushfire-prone areas*.

Refer to *WoodSolutions Technical Guide #4 Building with Timber in Bushfire-prone Areas - BCA Compliant Design and Construction Guide* for further information. It also should be noted that South Australia and NSW have some differing requirements than that of AS 3959 and these requirements need to be followed in those states.

HANDRAILS AND BALUSTRADES

If the deck is more than one metre off the ground handrails or balustrades are required. The choice of appropriate handrails and balustrades will depend on the design and application and even location in relation to other structures. For example balustrades for decks next to a pool vary from that of balustrades required in the NCC for fall protection. Further information can be found in *Wood Solutions Technical Guide #8 Stairs, Balustrades and Handrails – Class 1 Buildings – Construction*.

MAINTENANCE AND WEAR

All decks will benefit from regular maintenance. When cleaning the deck avoid hosing it down, instead use a broom or a blower. Pot-plants or other items should be elevated off the deck and be placed in drip trays. They should also be moved regularly, to even the weathering of the deck.

Timber is a natural product and as your deck timbers weathers, small cracks are likely to appear on the surface of the boards. These cracks are caused by the intermittent wetting and drying of the wood and are part of the character of wood and have no structural effect. This natural ageing process can be slowed by the use of finishes discussed above that reduce moisture movements in timber.



TANNIN, IRON STAIN AND RESIN BLEED

TANNIN BLEED

Most hardwood timber species contain water-soluble extractives which provide colour and some natural decay resistance to the timber. Water-soluble extractives may be leached to the surface of the timber whenever moisture leaves the timber. Because the discolouration is water-soluble, it can be washed to other surfaces and leave an unsightly stain which can be difficult to remove from brickwork, concrete or any paving which is underneath the deck unless they are sealed. To lessen the likelihood of such extractives bleeding and staining, use seasoned timber and apply a water repellent finish to all surfaces including any freshly cut ends. Also seal pavers or concrete elements underneath.

IRON STAIN

Any iron filings that are not cleaned from the surface are likely to react with moisture and the timber extractives to create unsightly black staining on the timber. Avoid using any tools on, near or above an uncovered deck which may deposit fine iron filings or dust on the timber surface. Particular care should be taken with cutting metal, masonry, brick or ceramics with an angle grinder. An angle grinder cutting bricks or tiles creates iron filings from the metal mesh which forms the base of the cutting disk.

RESIN BLEED

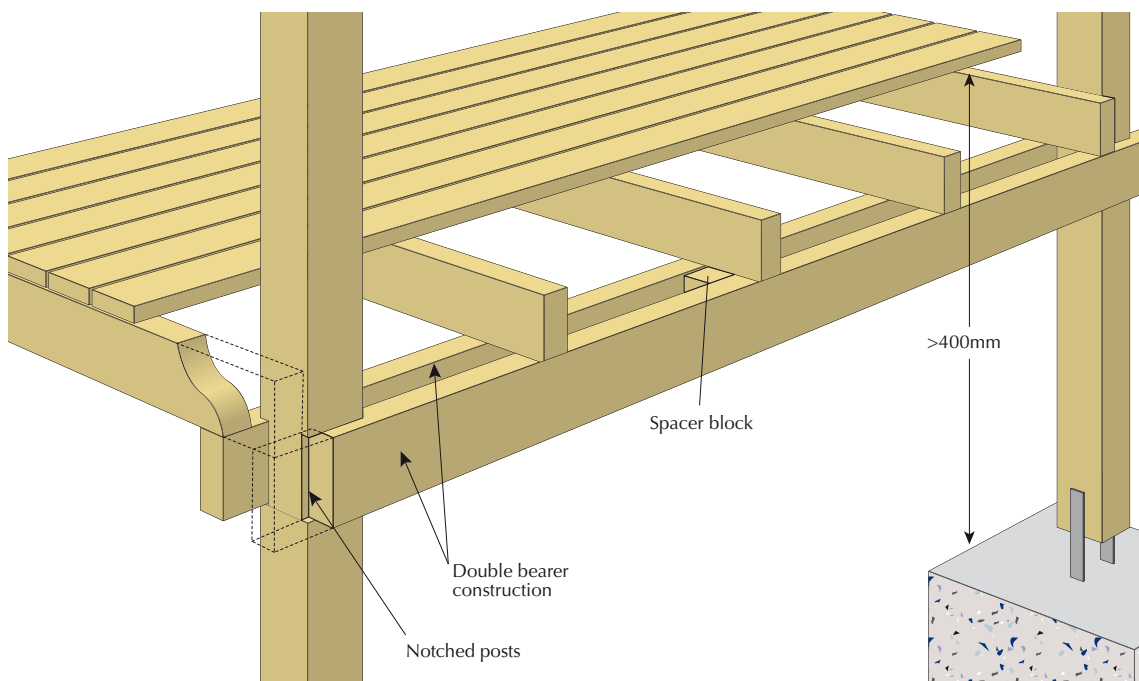
Some softwood timber species boards such as radiata and slash pine can be prone to resin bleed. Ideally if a board shows obvious signs of resin bleed then it is preferable not to use board or to cut out the affected area. If it has to be fixed in the deck, fix it in a position where the resin bleed won't be a problem. Sometimes it may not be obvious that a board is prone to resin bleed until after the finished deck has been exposed to a period of hot weather. In such circumstances the resin can be cleaned up or the offending board replaced.

SECTION B - SPECIFIC REQUIREMENTS

RAISED TIMBER DECKING

This is any timber deck where the decking boards are over 400 mm above the finished ground. It is assumed that there is appropriate drainage available for water and adequate cross-flow ventilation underneath the deck, refer Figure 8. Note that adequate cross-flow ventilation for decks is regarded as the same as the minimum requirement for raised timber floors in houses. For the minimum cross-ventilation requirements refer to NCC, Volume 2 Part 3.4.1.

Figure 8: Raised Timber Deck



SUB DECK SUPPORTS

The purpose of the sub deck supports is to transfer horizontal and vertical loads into the ground and sometimes includes uplift forces particularly where decks are covered with a roof.

FOOTINGS

Footings for supporting posts are generally designed in two ways. The most common method is concrete footings with galvanized stirrups embedded or fixed in the footings to support the posts, refer Figure 9. An alternative method to support the deck post is by embedding the post directly into the concrete footing. When this method is used care is required to use no-fines concrete, have adequate concrete under the post, and slope the top of concrete footing away from the post, refer Figure 10.

Figure 9: Post stirrups in concrete footings

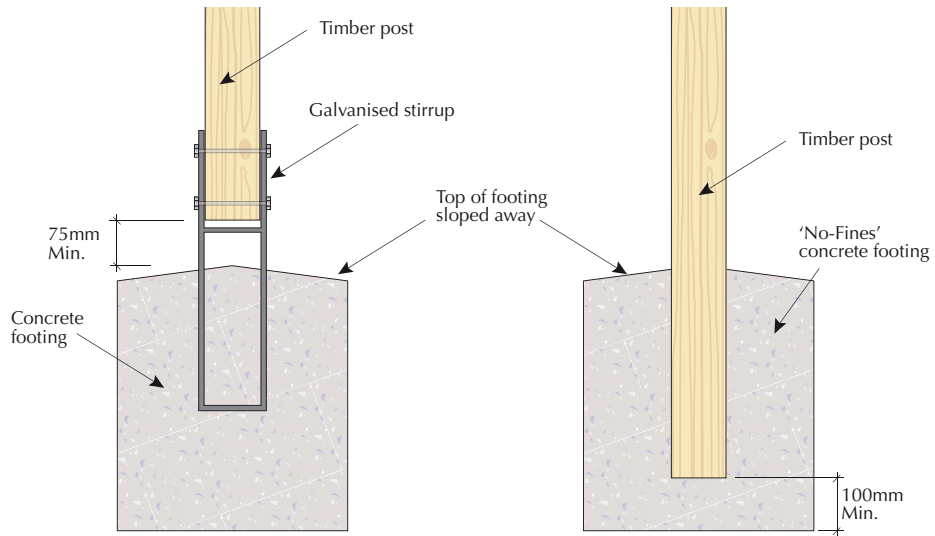


Figure 10: Post embedded into a concrete footing

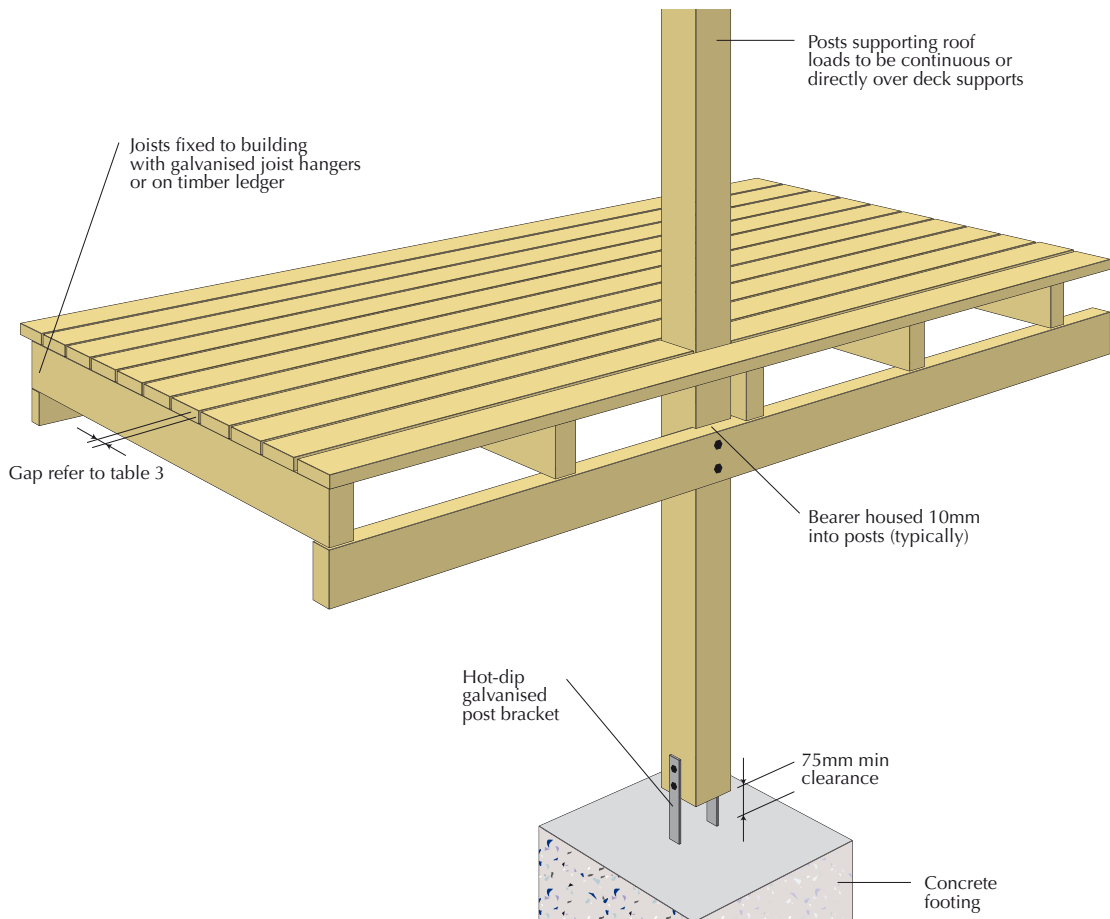
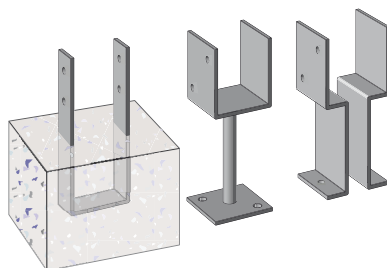


Figure 11: Proprietary Metal stirrups

The design of footings is outlined in AS2870 or AS1684. Generally the soil classification and expected loads on the deck are required to be known. Decks designed to AS2870 and AS1684 are for decks used for housing with average loads and ground conditions. If these conditions are not met, for example the deck needs to support a spa or the deck is to be tiled, the design needs to be considered by a structural engineer.

DECK FRAMING AND DECKING BOARDS

TIMBER SELECTION

Unless the deck is completely protected by a roof the timber framing and boards will be exposed to the weather; therefore it is essential that timber is chosen which can provide good service life in these conditions.

Those timbers used above the ground (framing, boards and posts on stirrups) should be hardwoods rated above-ground natural durability class 1 or 2 or, if softwood is used, preservative treated to H3 hazard level. Softwood timber that is treated to H2 hazard level is not suitable for use in the construction of decks.

Timber embedded in the ground (embedded posts) should have be in-ground natural durability class 1 or be preservative treated to H5 hazard level.

Refer to Appendix A for a list of common timbers and their above-ground and in-ground natural durability ratings.

There is a wide variety of engineered wood products now available on the market such as glue-laminated timber, finger-jointed timber and LVL products. If using these products reference to specific manufacturer recommendations is required as in most cases there are additional requirements or limits when these are used in applications such as decks where they are exposure to the weather. Note that timber I-beams (treated or untreated) are not suitable for use in the construction of decks.

POSTS

As described previously posts are generally connected to concrete footings via a stirrup. They are generally preservative treated softwood (H3 hazard level) or naturally durable (above ground Class 1 or 2) hardwood timber.

AS1684 span tables have the required timber sizes for posts. These are dependent on deck area, roof area (if any), the post height and stress grade of the timber selected. Common cross-sectional sizes for posts vary but generally commence at 88 mm and upwards. Minimum sizes for posts are also governed by the distance between the ground and the underside of the bearers.

The maximum height of a deck above the ground for a given post dimension is 15 times the face width of the post.

Deck posts need to be braced and AS1684 has various bracing methods. These methods are either cross bracing between posts, refer Figure 12 or as a cantilever timber stump, refer to Figure 13.

Figure 12: Braced Timber posts

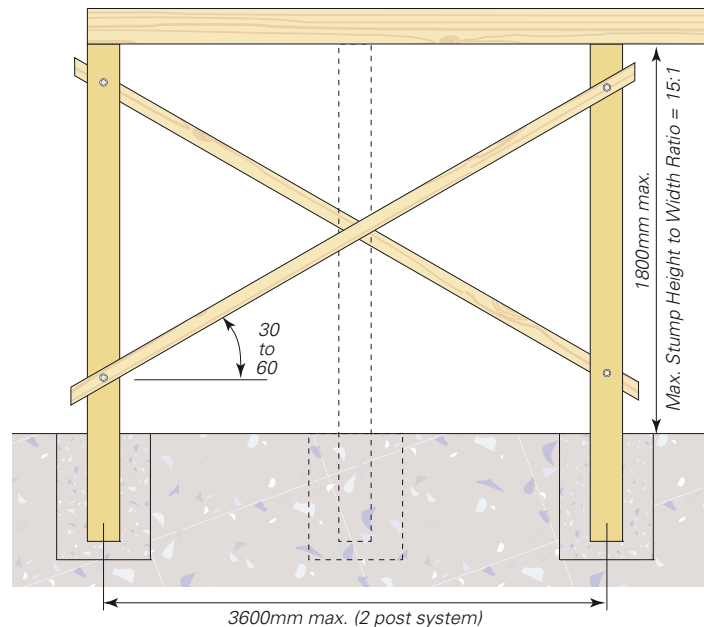
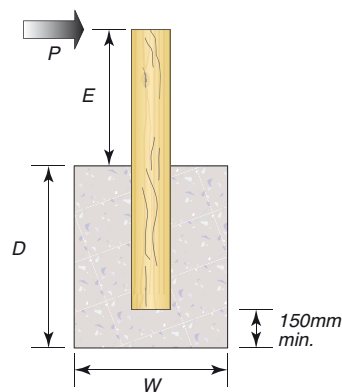


Figure 13: Cantilever timber stump



Deck board spacing

The purpose of spacing decking boards is to allow seasonal movement of the timber decking boards so that a gap is maintained to allow water to freely drain between the boards. The gap is not to be too far apart that it forms a trip hazard. The gap between the boards will be dependent on a number of elements;

- whether it is a hardwood or softwood timber species,
- the decking board cover width, and
- the moisture content of the timber during the installation process, i.e. unseasoned decking board requires less of a gap than seasoned decking boards.

A gap of 3 to 4 mm is ideal over the long term. Table 3 shows the recommended spacing at the time of decking board installation.

Table 3: Recommended decking gaps at installation

	Decking cover width (mm)	Seasoned or unseasoned	Recommended decking gap
Hardwood	86 to 90	Seasoned	3 - 4 mm
	91 to 140	Seasoned	4 - 5 mm
	86 to 90	Unseasoned	2 mm
	91 to 140	Unseasoned	2 mm
Softwood	70 to 90	Seasoned	4 mm
	91 to 120	Seasoned	5 mm

Note: In South Australia construction practices in bushfire-prone areas require a gap between decking boards of a set distance. Refer to NCC Volume 2.

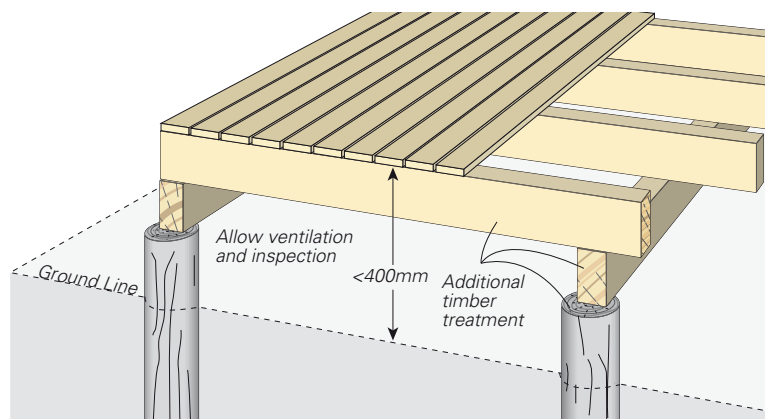
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DECKS CLOSE TO OR ON-GROUND

Where the decking is less than 400 mm off the ground additional consideration to ensure adequate performance and service life of the timber is required. These include increased ventilation, subsurface drainage, increased timber durability/preservative treatment and access for termite inspection and maintenance.

Where any of the conditions described in the guide cannot be met performance may be affected and the service life of the deck will be reduced.

Figure 14: Timber deck close to the ground



SUB-DECK AREA PREPARATION

It is important that the ground beneath the deck is completely cleared of all building rubbish, garden debris, or obstructions to water or air movement. Water must not be able to pool under the deck and the ground must be sloped away from the foundations of the house or other nearby buildings. Agricultural drainage pipes may be required in some instances so that water can properly flow away from beneath the deck.

Plastic sheeting acting as a water proof membrane should be placed on the cleared ground. If timber bearers are to be placed directly on the ground, the plastic sheet should then be covered with compacted gravel or sand to provide a solid base, refer Figure 16.

FOOTINGS

There are a two main ways these can be arranged: -

- Concrete beams, with joists sitting on top, with no need for bearers, refer Figure 15.
- Bearers placed straight on to the ground or soil, refer Figure 16.

Figure 15: Concrete beam footing

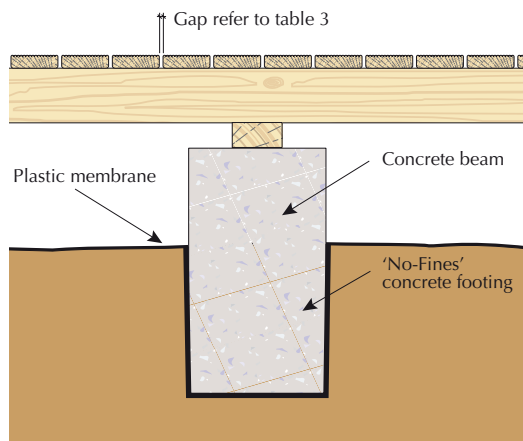
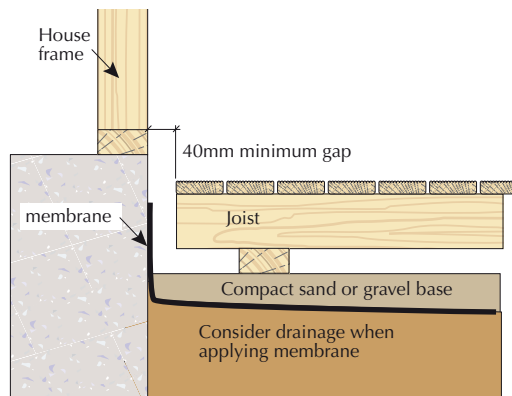


Figure 16: Bearer directly on to ground



Concrete foundations and bearers should be placed so that they do not restrict the flow or drainage of water. Preferably a decking system should be designed so that it is panelised. The panels need to be sized so that they can be easily lifted to allow for easy maintenance and inspection. The perimeter of the deck should be kept open to allow for ventilation.

TERMITE INSPECTION

Only termite resistant timber should be used (see below) and a gap between the house and deck of at least 40 mm maintained to allow for pest inspection, refer Figure 16.

DECK FRAMING AND DECKING BOARDS

TIMBER SELECTION

Timbers used close to or on the ground require additional durability as well as termite resistance.

Framing timbers more than 150 mm above the ground should be termite resistant and above ground durability Class 1 or 2 (plus sapwood removed or H3 treated) or softwood preservative treated to at least H3 hazard level.

Framing timbers on the ground or lower than 150 mm should be termite resistant and in-ground durability Class 1 (plus sapwood removed or H4 treated) or preservative treated to H4 or better.

Decking boards should be termite resistant above-ground natural durability Class 1 or 2 (plus sapwood removed or H3 treated) or preservative treated to H3 or better.

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DECKING BOARD SPACING

The decking should be the minimum width available and have a minimum spacing between boards (long term) of 5 mm to allow water to flow between the boards and ensure adequate ventilation.



APPENDIX 1 - COMMON DECKING BOARD TIMBER SPECIES


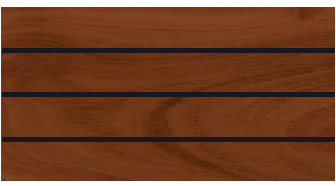




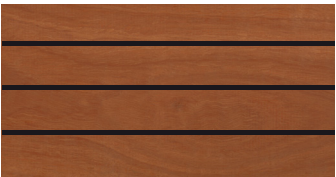
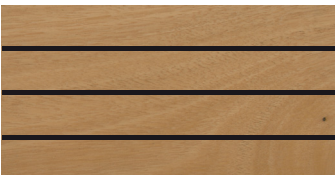




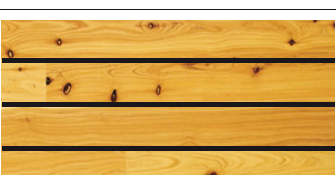
Image	Species	Common Sizes	In-ground Durability Rating	Above Ground Durability Rating	Termite Resistant	Bushfire Resistance
	Blackbutt	64 × 19 86 × 19	2	1	Yes	Bushfire Resisting Timber
	Red Ironbark	64 × 19 86 × 19	1	1	Yes	Bushfire Resisting Timber
	Grey Ironbark	64 × 19 86 × 19	1	1	Yes	Density greater than 750 kg/m ³
	Spotted Gum	64 × 19 86 × 19 136 × 32	2	1	Yes	Bushfire Resisting Timber
	Merbau / Kwila	70 × 19 90 × 19 140 × 25	3	1	Yes	Bushfire Resisting Timber
	Northern Box/Peliwan	90 × 19 140 × 25		1	Yes	Density greater than 750 kg/m ³

Image	Species	Common Sizes	In-ground Durability Rating	Above Ground Durability Rating	Termite Resistant	Bushfire Resistance
	Jarrah	65 × 19 88 × 19	2	2	Yes	Density greater than 750 kg/m ³
	Tallowwood	64 × 19 86 × 19	1	1	Yes	Density greater than 750 kg/m ³
	Turpentine	64 × 19 86 × 19	2	1	Yes	Bushfire Resisting Timber
	Treated Pine	70 × 19 90 × 19 120 × 25	H3	H3	Yes	No
	Red Mahogany		2	1	Yes	Density greater than 750 kg/m ³
	River Red Gum		2	1	Yes	Bushfire Resisting Timber
	Cypress				Yes	No

REFERENCES

Australian Building Codes Board, National Construction Code Series, Volume Two

Australian Standards

- *AS 1604 Specification for preservative treatments Part 1: Sawn and Round timber*
- **AS 1684.2 Residential timber-framed construction. Part 2: Non-cyclonic Areas**
- **AS 1684.3 Residential timber-framed construction. Part 3: Cyclonic Areas**
- *AS2870 Residential slabs and footings*
- *AS 1810 Timber - Seasoned cypress pine - Milled products*
- *AS 2796.1 Timber - Hardwood - Sawn and milled products - Product specification*
- *AS 2870 Residential slabs and footings standard*
- *AS 4785.1 Timber - Softwood - Sawn and milled products - Product specification*
- *AS 5604 Timber—Natural durability ratings*

WoodSolutions Technical Design Guides

- #4 – Building with Timber in Bushfire-prone Areas - BCA Compliant Design and Construction Guide*
- #5 – Timber Service Life Design – Design Guide for Durability*
- #8 – Stairs, Balustrades and Handrails – Class 1 Buildings – Construction.*
- #13 – Finishing Timber Externally*

Bootle, Wood in Australia, Second Edition

Scheffer and Morrell, Natural Durability of Wood: A Worldwide Checklist of Species



The Timber Development Association of New South Wales (TDA) is an industry funded association representing all segments of the timber industry, from manufacture to supply. For over 75 years, the TDA has effectively promoted the educated use of timber and timber related products.

The TDA was incorporated on the 21st October, 1938. Its original mission was to promote the use and sale of timber of all kinds — whether native to Australia or imported from abroad. It was also mandated to promote the interests of all persons, firms or companies in Australia involved with timber or wood technology, or engaged in forestry.

The TDA mission has evolved considerably over the years. The TDA now concentrates on the technical advancement of the timber industry.

FURTHER INFORMATION

Information on timber use can be found from TDA's website www.timber.net.au.

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