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Finishing Timber Externally

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WoodSolutions is an industry initiative designed to provide independent, non-proprietary information about timber and wood products to professionals and companies involved in building design and construction.

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Introduction

Timber needs to be well detailed, carefully selected and finished appropriately to work successfully in an external environment.

Finishing Timber Externally aims to provide an understanding of the important considerations of finishing timber elements externally. 'Finishing' includes surface treatments of timber elements, securing timber elements as part of a building envelope, and designing and detailing timber elements for maximum design life.

This guide complements the *Wood Solutions Guide #5 Timber service life design. Design guide for durability*. That guide provides information on the use of bare or treated timber in many external applications including in-ground posts, decks, fences and pergolas, and should be consulted for detailed information on these uses. This guide, *Wood Solutions Guide #13*, concentrates on the finishes used with timber exposed externally in decks or as part of the building envelope, such as cladding or external joinery.

Timber needs to be well detailed, carefully selected and finished appropriately to work successfully in an external environment. This guide discusses the material, finishing and fastening factors important to the in-service performance and longevity of external timber elements. It addresses using 'bare' timber externally in a contemporary context. It includes:

- a basic introduction to timber as a material;
- guidance on the wood products available and the external applications for which they are suited;
- information on selecting an appropriate finish, whether an applied finish or bare timber;
- an overview of finishing systems available including application and maintenance;
- fasteners;
- a summary checklist for the appropriate selection of finishes; and
- species information.

The information provided on applied finishes in this guide is representative of the suite of products available at the time of publication. System manufacturers should be consulted for more detailed information on specific products.

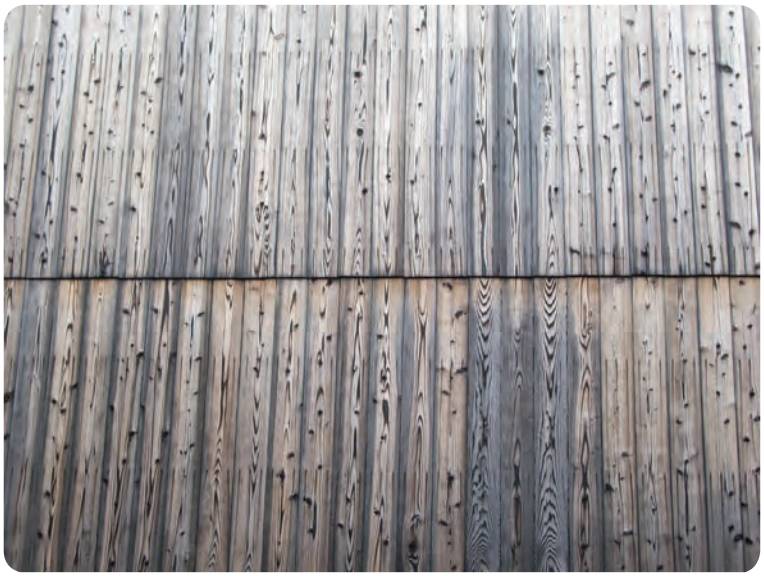

Figure 1: Bare timber used externally in a temperate climate.

1 Material basics

1.1 Introduction

This section provides an overview of how the natural characteristics of wood influence the timber used externally.

Timber is a sustainable material when it is obtained from trees that are grown and harvested as part of a managed and renewable cycle. This cycle can be certified through schemes such as the Australian Forest Certification Scheme or Forest Stewardship Council. These certification schemes require external auditing of forestry and supply-chain practices against internationally recognised standards to ensure sustainable practices are adopted. Timber used should be from a certified source.

Trees absorb carbon dioxide as part of the growing cycle which is sequestered in the converted timber or wood products. The energy required to convert the tree into a construction material is low compared to the energy required to obtain other common construction materials such as cement or steel. Therefore, timber is a material with both low 'embodied energy' and low 'embodied carbon'.

Figure 2: Native regrowth forest.

1.2 Timber characteristics

The physical properties of wood vary along the grain fibres or across them, radial to the log centre or tangential to the growth rings.

The cells that form the grain of the wood are like long hollow tubes that run up the trunk of the tree. The cellular structure influences the timber's character. The physical properties of wood vary along the grain fibres or across them, radial to the log centre or tangential to the growth rings. The character of timber obtained from a tree also varies with the species of the tree, the environment in which the tree is grown, and the location within the tree from which the timber is obtained.

Figure 3: Growth rings in pine glulam.

1.3 Moisture in timber

All timber contains some moisture. The moisture content (MC) – the amount of moisture in the wood at a particular time – is defined as the mass of water in a piece and is expressed as a percentage of its oven dry mass.

Timber freshly converted from a tree is 'green'. At this point, its MC is above the point at which moisture is saturating the timber cell walls. Typically, the timber would be dried or 'seasoned' to a moisture content aligned with that anticipated in service – generally between 12% and 18%. Drying timber increases its value and versatility by improving its dimensional stability, strength, stiffness, durability, insulating characteristics and workability.

After it has dried to service conditions, timber loses or gains moisture to be in equilibrium with its surrounding environment, shrinking with moisture loss and expanding with moisture up-take. The rate of moisture ingress or egress varies between species and whether the timber is coated. Most coatings are impervious to water but allow the transmission of water vapour. The ingress and egress is fastest through the end grain. Coatings applied to timber faces (other than end grain) should have balanced moisture permeability to avoid exacerbated distortion issues associated with differential drying. Shrinkage in-service may be as high as 12% of the section width or depth if timber is used green.

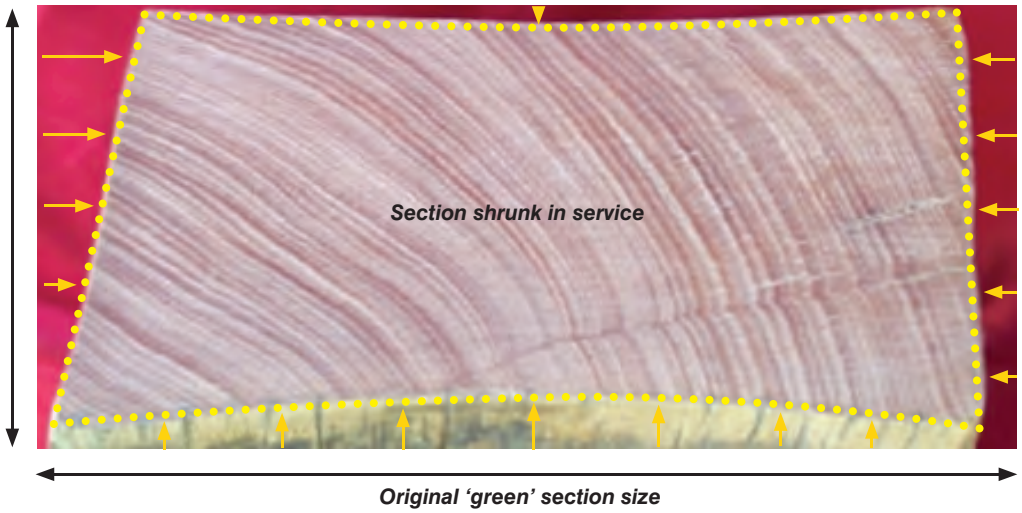

Figure 4: Shrinkage in a large unseasoned section.

On-going dimensional change of an installed element as a result of regular environmental changes is an inherent property of timber. Accommodating in-service movement is critical to the successful use of timber in external applications. These changes are predictable and the responsibility for accommodating them in external applications rests with:

- the designer/architect/specifier to ensure the material and its specified moisture content is appropriate for the application and the predicted movement in service can be accommodated;
- the contractor during assembly, site storage and installation to ensure the timber is protected and its moisture content at the time of installation is within the anticipated range; and
- the building user by following best practice maintenance procedures for the adopted external finishes.

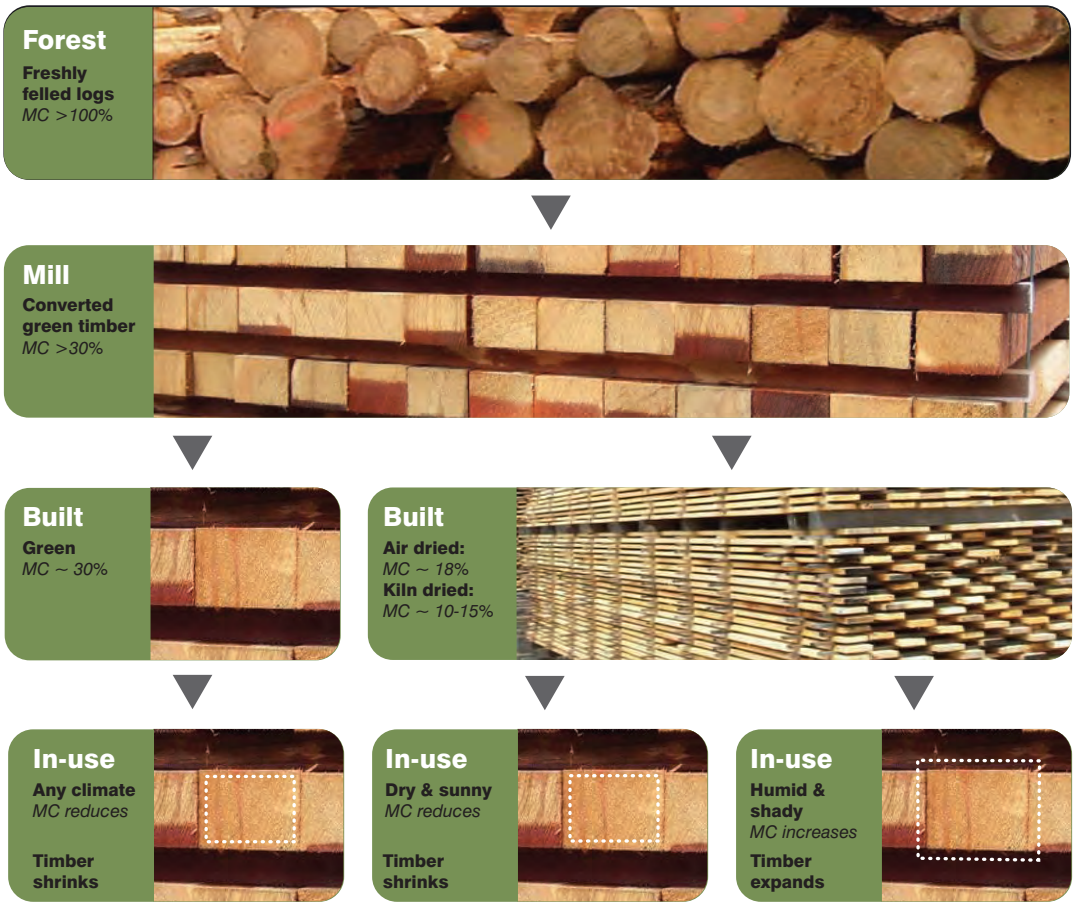

Figure 5: Changing moisture content through production and use.

2

Timber products

2.1 Introduction

This section provides a summary of the timber products available for use externally. The characteristics of each product influence their uses in external applications and suitability to produce a finish substrate or for use bare. The table below presents the most common products and comments on suitable uses, finishes, grades, species or other factors. Further information can be found from state Timber Associations, the Engineered Wood Products Associated Australasia (EWPAA), or product manufacturers.

Figure 6: Stained and coated external plywood cladding.

2.2 Timber Products Summary

Product	Uses externally	Finishes	Species/Grade	Comments
Round pole 	Canopies, bridges, retaining walls, telegraph/power poles, piles, piers, wharfs, temporary structures.	Used with penetrative treatment to low durability sapwood or untreated if a naturally durable species and the sapwood is removed.	De-barked or peeled/shaved. Species vary. Available in many stress grades. Refer AS1720.1 Section 6.	Sizes vary. Most readily available up to around 350mm diameter from forestry process. Care required to avoid splits or 'shakes'.
Solid Timber 	Structural elements, horizontal or vertical cladding, external joinery, decking, fences, furniture.	Finished with paint, varnish, stains and oils, or left bare. Preservative treatments can be used.	Graded structurally in F-grades from around F5 to F17, MGP grades, or appearance grades. See section 9 for common species data.	Size varies if sawn or machined. Decking and weatherboards usually 19mm thick and up to 175mm wide.
Glue-laminated timber 	Structural elements. Should be used in 'sheltered' locations with full flashing and surface protection.	Usually clear or translucent varnish applied, though can be painted. Preservative treatments can be used.	Structural grades GL8 to GL18. Visual characteristics usually determined by structural grade required Typically non-durable species.	Made up of small timber elements glued together. Length usually limited by transportation.
Plywood 	Cladding in large panels or cut into strips as weather boards.	Painted or varnished, or can be used unfinished if durable species and adhesives used.	Range of grades from low durability, low quality to durable exterior and marine plywood. Type A and B bond required for external use.	Panels made from veneer peeled from logs. Dimensionally stable. Common sizes 1.2m x 2.4 or 3.2m sheets. 7, 12 or 18mm thick.
Laminated veneer lumber 	Structural elements. Should be used in 'sheltered' locations with full flashing and surface protection.	Usually a translucent varnish or paint applied. Available with factory applied termite protection	Peeled, low durability plantation softwood with bond Type A.	Size varies by manufacturer. From around 35 x 90mm to 75 x 600mm.

3

Factors affecting the selection of finishes

3.1 Introduction

This section provides guidance on selecting appropriate finishes based on considerations of project performance requirements, site conditions, and timber characteristics, including the use of preservative treatments. Sources for more detailed information on each of these influencing factors are included in the relevant sub-sections below.

3.2 Finish performance requirements

The choice of finish will be driven by aesthetic requirements along with a compromise between the higher initial capital costs associated with higher-quality products and the higher ongoing maintenance costs associated with with lower-quality products and details.

For a given project, the design team should develop a preliminary strategy for finishing external timber elements such as cladding, external joinery and decks using information provided in this guide. Designers should consult *AS/NZS 2311 Guide to the Painting of Buildings* and seek advice from a manufacturer of appropriate finish types to develop a detailed specification containing the selected finish product type, substrate preparation, section preparation, priming, number of coats for different elements, and maintenance.

The choice of finishing system and timber species to be used will typically differ between vertical envelope elements, external joinery and decking because the level of exposure, cost and ease of replacement and amount of abrasion varies with each.

Developing a specification for an acceptable design life of an element should be developed with the design team and clients on a project-by-project basis considering ease of access, cost of replacement and likely building refurbishment intervals. The design life for external cladding element of a house might be as low as five years if access is easy and cost of replacement is relatively low. If access is difficult and replacement is expensive then the elemental design life of the cladding should match that of the building.

Figure 7: Painted plywood cladding, varnished timber joinery.

3.3 Timber

The characteristics of the timber used as a substrate for finishes or as a bare, exposed element has significant influence of the choice and subsequent performance of the finished element in service.

3.3.1 Substrate influence on performance

The characteristics of the timber used as a substrate for finishes or as a bare, exposed element has significant influence of the choice and subsequent performance of the finished element in service.

Timber characteristics which affect the performance of the applied finish include:

Species – The performance of different finishes varies with the species and density of the timber onto which the finish is applied. Consult finish manufacturers for detailed information on the varying performance of their products with different species.

Surface texture – Smooth surfaces offer better substrates for painting than rough surfaces. Dressed timber offers a better performance than rough-sawn timber for film-forming systems such as paints. Rough sawn timber can be used with penetrating systems such as oils and stains.

Moisture content – Seasoned timber (10 to 18% MC) provides a more stable substrate than green timber, reducing problems of cracking associated with movement of the timber under a coating. Moisture egress associated with in-situ drying of green timber can lead to blistering of finishes with low vapour permeability such as paint, so stains and oils are best adopted if the timber is green or has a high moisture content when installed and coated.

Section profile – Section edges should be arrissed or rounded to prevent concentration in coating stress for film-forming finishes. For film-forming systems such as paint, sections adopted should be as dimensionally stable as possible. Quartersawn sections are more stable then backsawn sections.

Material features – The heartwood of timber has a higher natural durability than sapwood but is harder to treat with impregnated treatments. Timber features or 'defects' will affect the finish's performance. Gum pockets can lead to resin exudation and staining unless pre-treated and sealed. Aromatic oils can lead to drying retardation and staining if surface oils are not removed. Knots can cause premature cracking and staining of the finish unless treated with knotting varnish or the manufacturer's recommended treatment. Bark left on the piece can lead to premature failure of all film-forming finishes if not removed. Extractives may cause topcoat discolouration or blistering unless the surface extractives are removed with a solvent wash prior to priming.

Surface checking –The timber grain fibres can become separated as the timber dries and shrinks, and splits or checks form on the surface. Surface checks generally have minimal effect on the structural performance of elements (unless at a critical connection) but may affect the integrity of finishes. Providing a coating which reduces the rate of shrinkage can help prevent surface checking.

Surface check ***Knots*** ***Gum vein***

Figure 8: Common material features affecting finishing.

3.3.2 Weathering

Weathering is the greying and minor cracking of a timber surface caused by light, dust or recurrent wetting and drying.

In mild or temperate climates, weathering is a slow process and would not typically lead to sufficient degradation to leave an element unserviceable in a normal design life. In harsher climates, such as the tropics or subtropics, weathering can be severe and lead to early degradation of the timber or finishes, such as checking, splitting and distortion of the timber.

Weathering affects appearance, the performances of finishes and eventually the decay rate, as water retained in any indentations in the surface of the timber or under any fractured finishing coat can nurture the growth of fungi.

Figure 9: Weathered, grey surface adjacent to unweathered surface.

Weathering is often considered a desirable attribute in building facades. However, care must be taken to ensure any differential weathering patterns associated with overhangs and sheltering are considered

Area A
Exposed: weathering to a grey colour

Area B
Run-off: biological deterioration at wettest part

Area C
Protected: remains close to original colour

Area D
Splash-back: biological deterioration with splash-back from ground

Figure 10: Differential weathering across a façade.

The greying of bare timber associated with weathering is often considered a desirable attribute in building facades. However, care must be taken to ensure any differential weathering patterns associated with overhangs and sheltering are considered. Figure 10 shows a façade undergoing several distinct regions of weathering and deterioration.

3.3.3 Durability

Timber's resistance to hazards

The long-term performance of timber finishes in external applications is influenced by the durability of the timber, whether used as bare timber or finished with an applied system. Timber resists decay and insects naturally or with the assistance of added preservative treatments or coatings.

The natural durability of a piece of timber – its resistance to decay without treatment – is a characteristic of the species. Timber species are rated in durability classes 1 to 4 for exposed in-ground contact and exposed out-of-ground contact in *AS 5604-2005 Timber – Natural durability ratings*. Class 1 is the most durable with design life greater than 40 years; class 4 is the least durable with design life as low as zero years. Species data sheets included in section 9 present the durability classes for commonly adopted timbers. More information can be found in *Wood Solutions Guide #5 Timber service life design guide*.

Timber's natural resistance to decay and insects can be enhanced by adding preservative chemicals which are a combination of insecticides and fungicides. Preservative treatments are impregnated into the timber by soaking or under pressure at the sawmill or secondary processing facility.

AS 1604-2010 Timber – Preservative-treated – Sawn and round identifies the degree of hazard present for the timber. Timber that is outside and above ground is categorised as Hazard Class H3, whether it is under the shelter of eaves or subject to full exposure of sun and wind. Treatment requirements are specified based on the Hazard Class present. For example, low-durability timber can be treated to H3, meaning it is suitable for use in any location outside above ground provided it is appropriately detailed.

AS 1604-2010 specifies the requirements for preservative treatment necessary to achieve a defined level of protection for the Hazard Class including the penetration and retention of chemicals in the timber. Not all timber can be successfully treated to the penetration or retention level required by AS 1604 using currently available commercial processes. Generally, the sapwood of all species can be treated to H3 but the heartwood of most species resists consistent treatment because the preservative cannot penetrate into the timber sufficiently. The preservative treatment is compromised if the section is cut. Exposed ends of cut treated timber should be dipped in preservative to maintain the envelope protection.

3.3.4 Bushfire

The choice of applied finish or timber species used externally may be governed by the required performance in bushfire. External timber elements are required to achieve certain bushfire-resisting performance in *AS 3959-2009 Construction of buildings in bushfire-prone areas* for a given bushfire attack level (BAL) which is determined on a project specific basis. In AS 3959 Appendix E, timbers are classified as naturally bushfire resisting or able to provide certain levels of resistance based on the density of the material. Alternatively, timber can be treated with intumescing paint or impregnated treatment to achieve bushfire-resisting properties. *Wood Solutions Guide #4 Designing for Bushfire* contains more detailed information.

Figure 11: Sheltered bare timber.

Figure 12: Bare timber shingles.

The level of exposure of the element to hazard is influenced on a regional scale, a local scale and a building scale.

3.4 Site environment

The environment surrounding the timber element defines the exposure of the element to hazards, and so influences the choice and detail of an appropriate finish. The level of exposure of the element to hazard is influenced on a regional scale, a local scale and a building scale.

3.4.1 Exposure

Climate conditions influence the level of moisture, humidity, heat and sunlight that an element has to resist. This affects the performance of the timber, embedded fastenings and any applied finishes. Generally, the timber exposed to a climate that is regularly damp or wet will decay faster than timber in a dry climate. Moist and warm climates further accelerate the decaying process. ***Wood Solutions Guide #5 Timber service life design guide*** defines four regional climate zones, shown in Figure 13. The zones consider the regional environment to provide an indication of decay potential for above ground timber and the severity of environment a finishing system must endure in service. ***Wood Solutions Guide #5*** provides typical service life for different forms of construction with different treated and untreated species in these zones.

Local site conditions such as the slope of the land, the surrounding vegetation and the proximity of lakes or the ocean modify the local climate, potentially reducing or increasing exposure to rain, wind, sunshine and persistent moisture, and can introduce additional hazards affecting finishes. The south side of hills in temperate, wet climates will generally be damper than the north side and more conducive to decay. Proximity to the sea, especially salt spray near the ocean, can significantly influence the performance of fasteners and coatings.

The position of an external timber element in the building also affects its durability and the durability of finishes. Elements on the south side of buildings are generally protected from direct sunlight. In hot climates, this protection can significantly increase the service life of finishing systems. In cool and wet climates, the regularly higher moisture content of the timber on the south side of the building can potentially expose it to increased decay.

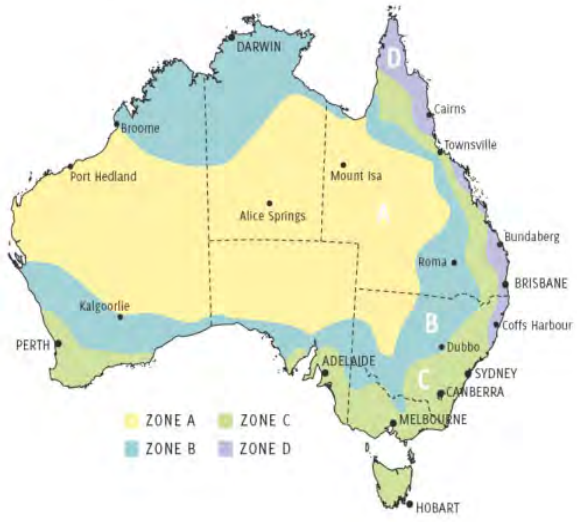

Figure 13: Above-ground decay hazard zones. (Zone D has the highest decay potential.)
Source: Wood Solutions Guide #5 Timber service life design guide

3.4.2 Biological deterioration

Fungal attack can occur if the timber's moisture content is maintained above about 20% and the temperature is between 5° to 60°C. Fungal attack will lead to decay of the timber, which compromises the durability of subsequently applied finishes and reduces the service life of bare timber elements.

The temperature on the outside of a building is hard to control, but it is possible to limit the moisture content to under 20% by shedding water, keeping moisture out of the joints and allowing wet timber to dry out. Decay can occur on any surface of timber but tends to attack the end-grain of any unprotected element most vigorously. Absorption through the end grain of the element can be much quicker than through the surface grain and the higher moisture content encourages fungal growth. The rate of end-grain absorption can be reduced by coating the timber.

3.4.3 Resistance to chemicals/pollution

Finished timber elements exposed externally may be subject to high levels of pollution from adjacent traffic or industrial process. Timber is resistant to all but the strongest alkalis and acids (pH>10 and pH<2). Most pollutants of levels acceptable to humans will be unlikely to affect the timber, accept for the accumulation of dirt and discolouration. Guidance is given on the performance of finish types in the summary tables in section 6. However, seek advice from manufacturers of finishes for the performance of their products in highly polluted or unusually acidic or alkaline environments.

Adhesives used for wood products such as glulam and plywood are typically robust enough for the majority of common applications. However, seek specialist advice from the manufacturer or the Engineered Wood Products Association Australasia if the site in which the timber product is to be used has an extreme ambient environment.

3.4.4 Resistance to abrasion

Timber and finishes used for trafficked elements such as deck boards are required to resist abrasion. The Janka hardness is a measure of the resistance of an element to indentation and can be taken as an indication of the resistance to abrasion. Janka hardness values are included for species summary sheets in section 9. For commercial flooring, a Janka hardness of greater than 7 kN is recommended. Abrasion resistance can be aided by applying the correct finishing system or additive as part of an overall finishing system. A qualitative guide to abrasion resistance of different systems is given in the product summary sheets in section 5 and further advice can be obtained from the manufacturers.

3.5 Selecting timber and finishes appropriate for the conditions

The durability of the timber and finishes is affected by the hazard presented by the surrounding environment, the resistance of the timber to decay and weathering, the arrangement of species, the quality of assembly and any finish or treatment on the timber.

Australian standards allow the consideration of durability, exposure, and detailing as a whole. For example, *AS 2047 – 1999 Windows in buildings – Selection and installation* suggests that for any given project regional advice can be obtained from state forest authorities or timber industry associations, but that generally timber windows may be constructed of either:

- Durability Class 1 or 2 timber;
- timber treated in accordance with AS 1604–1997; or
- any durability class, provided that it is protected from ingress of moisture by appropriate joint details, and either the application of a protective coating or installation under a protective shelter, such as a verandah.

AS 1684.2-2006 Residential timber-framed construction provides guidance on the specification of structural timber elements for sub-classes of exposure within different hazard classes. Several categories are suggested within Hazard Class H3 (above ground external) to refine the possible elemental durability and treatments specified. For example, durability class 1, 2, 3 or 4 timbers can be used externally above ground if protected by an eave or overhang, assuming the overhang protects elements within 30° to the vertical, and they are well detailed, painted or stained and maintained.

Matching the hazard present to the durability of timber with the design service life is essential in finishing timber externally. Table 1 provides the anticipated service life of bare timber elements in an above ground exposed cladding application. Information in the table is derived from *TimberLife Educational Software V1.0* available from WoodSolutions.

Table 1: Anticipated service life

Exposure zone *See Figure 13*	**Above ground durability class**			
	1	**2**	**3**	**4**
Zone A	62 years	51 years	30 years	17 years
Zone B	51 years	42 years	25 years	14 years
Zone C	41 years	34 years	20 years	11 years
Zone D	36 years	30 years	18 years	10 years

Further information can be found in *Wood Solutions Guide #5 – Timber service life design guide*. Assumptions made in determining the service life include that:

- termites and sapwood have been excluded;
- elements are appropriately detailed, installed and maintained;
- element size is 10 to 20 mm thick, by 50 to 200 mm wide; and
- elements are assumed to be in continuous contact with adjacent members.

3.5.1 Detailing and designing to increase design life

For any given climate, location and project, there are simple steps in design and specification that can increase the design life of timber and finishes used externally. These generally assist by excluding or shedding moisture and protecting surfaces from sunlight.

For any given climate, location and project, there are simple steps in design and specification that can increase the design life of timber and finishes used externally.

- Provide eave overhangs and verandahs sufficient to shade the elements from the harshest direct sunlight and rain. Overhangs required for shading can be defined by regional sun paths. They are generally considered to provide shelter from rain if they project an angle of 30° to the vertical.
- Place boards with surface features such as knots in areas of lower exposure. Such features can provide weaknesses in water shedding and finish integrity.
- Adopt timber profiles with rounded arrises rather than sharp corners to promote shedding of water and reduce stress concentrations in surface finishes associated with sharp corners.
- Provide adequate ventilation to allow rapid drying of areas that do become moist.
- Use the recommended fastener size and pattern for various types of timber cladding to prevent moisture movement becoming constrained and to provide sufficient structural connectivity.
- Use vertically orientated rather than horizontal cladding. This removes horizontal ledges that can trap and retain moisture.
- Detail drip caps over doors and windows to ensure that incidental rain and moisture is shed from the joinery and does not seep into timber elements.
- Avoid or minimise joints in horizontal cladding because these typically allow moisture ingress

Figure 14 shows deterioration of a façade with differential exposure conditions on adjacent elevations. The more exposed elevation on the right faces more onerous hazards from the site conditions and is less protected by overhangs than the more sheltered facade on the left.

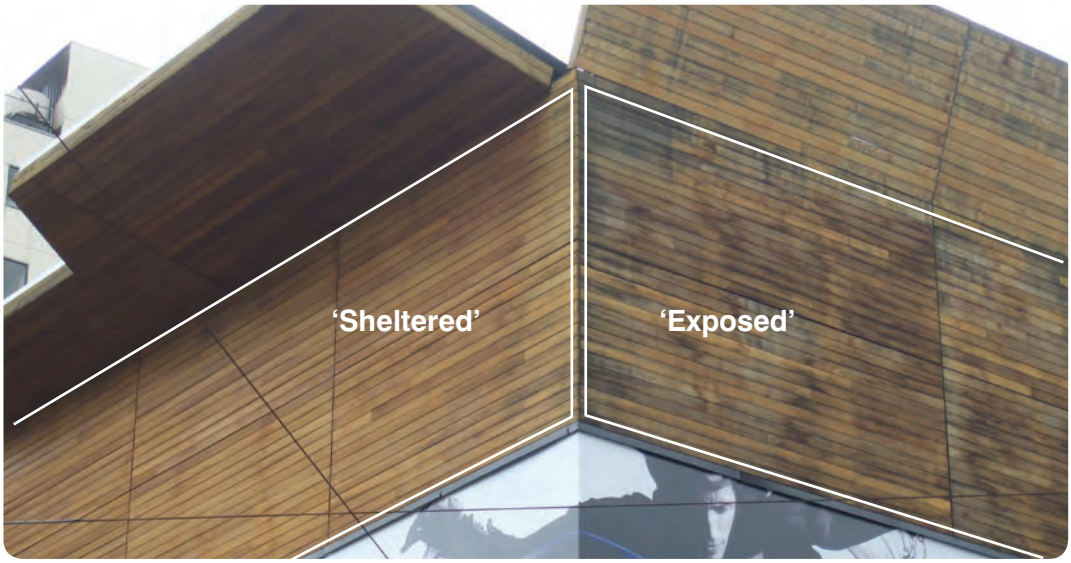

Figure 14: Differential deterioration on facades.

Figure 15 presents good practice with respect to preventing water ingress into a bare timber clad wall. A flashing is used on the upward facing elevation of the elements to protect the end grain, a clear drip space is left at the base which allows water run-off, the timber façade is lifted from the ground on a concrete plinth to prevent splash-back of rain on the ground surface, and the base of the boards are bevelled to form a drip line.

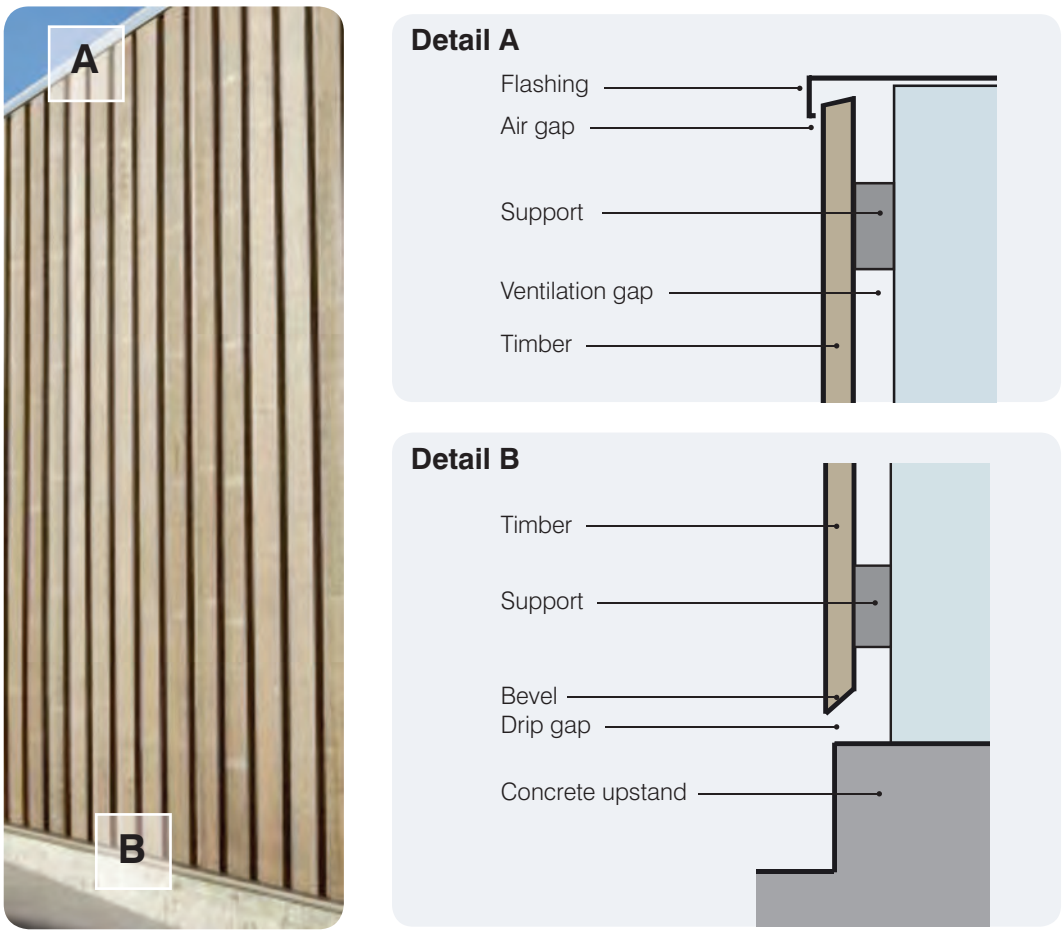

Figure 15: Detailing to avoid standing water.

4 Finishing systems

4.1 Introduction

This section provides a summary of different options available for finishing timber externally. 'Finishes' describes the in-service surface of the timber element and includes bare timber. The choice of finish will be influenced by the combination of factors described in section 4. The availability of finishes is both time and region dependent and so cannot be covered meaningfully in this guide. General qualitative guidance is given to the anticipated installation and maintenance costs for finishes. Quantitative costs should be developed for specific projects. ***AS/NZS 2311 Guide to the Painting of Buildings***, and product manufacturers and suppliers, should be consulted for more detailed information.

4.2 Finishing system basics

All applied finishes, whether transparent, translucent or opaque, provide some degree of film or 'coating' on the surface and to some extent fill voids in the microscopic surface structure, penetrating the surface. Finishes are generally either predominantly film forming or penetrating, but will generally feature some characteristics of both. Film-forming and penetrating finishes vary in thickness and in the finished shape of the surface they create. Film-forming finishes appear as a distinct layer on the surface of the timber, visually creating a smooth surface. Penetrating finishes follow the contours of the timber surface, providing thicker deposits in the troughs and thinner coatings over the peaks, leading to colour variegation over the surface and emphasising the grain. Incorrect specification or poor maintenance of a film-forming finish can lead to accelerated degradation rather than protection of the timber substrate, as moisture enters through the cracked surface and becomes trapped with the timber.

Figure 16: Poorly maintained paint which is trapping moisture.

Film-forming finishes are more resistant to wear because they feature a greater film thickness, but penetrating finishes are better able to accommodate the differential movement of timber caused by moisture variations. The advantages of penetrating finishes over film-forming finishes include:

- natural appearance
- do not peel or blister
- suited to sawn textured surfaces
- do not trap moisture in timber
- more easily applied
- more easily maintained, but require more frequent maintenance.

Transparent coatings and stains are typically a combination of film-forming coating and penetrating oil with added preservatives, fungicides, and colourants. The oil improves appearance and adhesion, while the surface coating protects the timber from wear and excludes moisture. The degree of film formation and penetration varies with product and manufacturer.

Transparent coatings and stains protect the timber while the grain and texture of the timber remain visible. The preservatives and fungicides in these finishes provide some degree of protection but they are not substitutes for preservative treatment to AS1604. These finishes can shed water and can provide UV resistance, particularly with some pigmentation, but the surface of the timber can still weather. Weathering leads to cracking or peeling of the finish if exposed to sunlight over time.

Penetrating oil finishes can contain preservatives and fungicides but are generally not long-lasting in external applications, particularly when regularly exposed to sunlight. The oil may also become a food source for fungi and can eventually encourage surface mould.

Paints are opaque, film-forming finishes which protect the timber from water, sunlight and abrasion. Paints are generally applied at higher film thicknesses than stains and are able to conceal light texture in the surface of timber. As UV cannot reach the surface of the timber and break it down, these finishes last much longer than translucent coatings. Paint needs to be flexible as the timber slowly expands and contracts with changes in moisture content.

Paints are typically used in a system that includes a priming coat. Wood primers provide good adhesion to the timber and a good base for inter-coat adhesion of subsequent coats.

Most modern paint coatings for timber, including primers, are water-based acrylics. Acrylics do not have the chemical emissions commonly associated with solvent-based finishes, are easier to apply and clean up, and have a shorter recoat time. Older acrylics did not have the durability of solvent-based paints but acrylics have significantly improved and are now the preferred systems for coating external elements.

Figure 17: Painted timber doors and surrounds.

Light colours are generally more durable than darker colours because they do not absorb as much heat from sunlight.

Film-forming paints can become brittle through prolonged exposure to UV and can breakdown and flake away from the timber. The flexibility and resistance to breakdown is usually directly related to the quality of the product and of the installation. Water-based acrylic systems are typically more flexible than solvent-based systems. Light colours are generally more durable than darker colours because they do not absorb as much heat from sunlight.

4.3 Finish type summary tables

The following tables present information on six generic types of finish ordered from most to least transparent. The information presented aims to be generic but representative. Details will vary between products and manufacturers.

Bare untreated timber

Initial cost: High

Maintenance cost: Very low

Description:
A suitably durable species used without treatment or finish for cladding or decking elements. Exposure, detailing and natural species' durability has to be matched to suit particular applications. Timber can be used green or seasoned. Timber will weather over time, changing colour depending on the level of exposure. Class 1 durable species includes Blackbutt, Spotted gum, Tallow wood, and Merbau. Prefer certified timber, especially with imported species. High initial material costs.

Features:
- Timber texture remains
- Colour will change with weathering depending on exposure
- Timber MC changes uninhibited

Benefits:
- Little on-going maintenance
- Lowest environmental impact solution (depending on source of timber and quality of detailing)

Uses: All exterior elements except external joinery.

Life to first maintenance period: Little or no maintenance

Typical Performance (resistance to):

Heat	Good
Solvent	Good
Acid	Good
Mechanical degradation	Poor
Salt	Unaffected
Abrasion	Good with harder species
Alkali	Good

Typical Properties:

Gloss Level	N/A
Finish	N/A
Colour	Timber colour with gradual colour change due to weathering
Toxicity	None
VOC	None
Touch dry/recoat	N/A
Application Method	N/A
No. Coats	N/A

Precedents:




Oil

Initial cost: Low

Maintenance cost: Low to medium

Description:
Penetrating oil composed of a blend of natural and synthetic oils in combinations varying between manufacturers. Also available with added pigments which provide UV protection (pale colours provide maximum protection). Resistance to fungal and mould growth varies between products and manufacturers.

Features:
- Nourishes timber
- Timber pattern and texture remain
- Water repellent

Benefits:
- Will not crack, peel or blister
- Can be UV, mould and fungus resistant
- Can be naturally and sustainably derived oils
- Fast drying

Uses: All exterior timber including decking and rough sawn timber

Life to first maintenance period: 1-3 years

Typical Performance (resistance to):

Heat	Up to 120°C
Solvent	Resists mineral turps.
Acid	Fair
Salt	Unaffected by splash and spillage
Abrasion	Moderate resistance
Alkali	Fair

Typical Properties:

Gloss Level	Nil
Finish	Penetrating
Colour	Clear to translucent to pigmented
Toxicity	Lead free. Can be non-toxic
VOC	<665 g/L
Touch dry/recoat	0.5 hr/4 hrs
Application Method	Brush, pad
No. Coats	2

Swatches:

Clear exterior varnish

Initial cost: High

Maintenance cost: High

Description:
A tough, clear, water-based predominantly film-forming finish with possible added UV protection (depending on product). Provides a glossy surface finish while revealing grain beneath.
Cost of application usually high.

Features:
- Water based
- Non-yellowing
- 100% acrylic
- Low odour

Benefits:
- Fast drying and easy clean up
- Retains natural timber colour and grain
- Tough and durable
- Can be UV resistant

Uses: Window frames, doors and trims

Life to first maintenance period: 2 years

Typical Performance (resistance to):

Heat	Up to 70°C
Solvent	Fair.
Acid	Fair
Salt	Unaffected by splash and spillage
Abrasion	Moderate resistance
Alkali	Fair

Typical Properties:

Gloss Level	Gloss or satin
Finish	Predominantly film forming
Colour	Clear
Toxicity	Dry film non-toxic
VOC	<90 g/L
Touch dry/recoat	1 hr/4 hrs
Application Method	Spray, brush, pad
No. Coats	3 or 4 in high exposure areas

Precedents:

Pigmented exterior varnish

Initial cost: Medium to high

Maintenance cost: Medium to high

Description:
A tough, clear, water-based predominantly film-forming finish with possible added UV protection (depending on product). Provides a glossy surface finish while revealing grain beneath. Cost of application usually high.

Features:
- Water based
- Non-yellowing
- 100% acrylic
- Low odour

Benefits:
- Fast drying and easy clean up
- Retains natural timber colour and grain
- Tough and durable
- Can be UV resistant

Uses: Window frames, doors and trims

Life to first maintenance period: 2 years

Typical Performance (resistance to):

Heat	Up to 70°C
Solvent	Fair
Acid	Fair
Salt	Unaffected by splash and spillage
Abrasion	Moderate resistance
Alkali	Fair

Typical Properties:

Gloss Level	Gloss or satin
Finish	Predominantly film forming
Colour	Clear
Toxicity	Dry film non-toxic
VOC	<90 g/L
Touch dry/recoat	1 hr/4 hrs
Application Method	Spray, brush, pad
No. Coats	3 or 4 in high exposure areas

Swatches: *Colour by manufacturer*

Precedents:

Stain

Initial cost: Low to medium

Maintenance cost: Low to medium

Description:
Penetrating stains available in many tones. Stains soak into the timber surface once applied leaving grain pattern and texture. Grey stains can be used as a temporary coating to achieve apparent weathering while timber behind weathers to grey.

Features:
- Lightly pigmented
- Water based
- Grain and texture remain

Benefits:
- Can block tannins to prevent staining
- Can be mould and UV resistant
- Slip resisting additives available

Uses: External joinery, cladding, decking and furniture

Life to first maintenance period: 3-6 years

Typical Performance (resistance to):

Heat	Softens above 70°C
Solvent	Fair
Acid	Fair
Salt	Good
Abrasion	Moderate resistance
Alkali	Fair

Typical Properties:

Gloss Level	Matt – low sheen
Finish	Penetrating
Colour	Varies with manufacturer
Toxicity	Lead free. Dry film non-toxic
VOC	<75 g/L
Touch dry/recoat	1 hr/3 hrs
Application Method	Spray, brush, pad
No. Coats	2 to 3 (more if the surface is horizontal)

Swatches: *Colour by manufacturer*

Precedents:

Paint

Initial cost: Medium to high

Maintenance cost: Medium

Description:
Opaque coloured film-forming paint for surface coating timber. Usually applied as a system with primers and top coats. Can be factory or site applied. Traditionally available in solvent or acrylic compositions. Solvent-based paints are becoming rare. Light colours tend to have a longer service life.

Features:
- Large colour range available
- Slows or prevents moisture changes in timber
- Typically oil enriched acrylic
- Can be thinned by <10% water for warm or highly absorbent surfaces.

Benefits:
- UV and mould resistant
- Water resistant
- Tannin block (but does not seal knots)
- Can be self-priming but usually used with system primer

Uses: All exterior timber including decking

Life to first maintenance period: 7-10 years

Typical Performance (resistance to):

Heat	Softens above 70°C
Solvent	Sensitive to alcohol and hydrocarbons
Acid	Dilute splash-proof
Salt	Resists salt spray
Abrasion	Good resistance
Alkali	Dilute splash-proof

Typical Properties:

Gloss Level	10 to 20%
Finish	Predominantly film forming
Colour	Any possible
Toxicity	Lead free. Dry film non-toxicxic
VOC	<65 g/L
Touch dry/recoat	0.5 hr/2 hrs
Application Method	Spray, brush, pad
No. Coats	2 to 3

Precedents:



5

Applying & maintaining finishes

Generally, site finishing provides a greater flexibility of construction process and sequence, but factory finishing provides a higher quality of finish.

5.1 Introduction

This section presents key considerations and guidelines for the application and maintenance of the various finishes. Consult manufacturers for detailed information on the use of specific products.

5.2 Site- or factory-applied finishes

The choice of site- or factory-applied finish will be determined by the finish type, the element size, type and form, and the construction process. Generally, site finishing provides a greater flexibility of construction process and sequence, but factory finishing provides a higher quality of finish.

Site

Timber cladding elements used externally may be installed bare or with a low-protection factory finish and subsequently finished in situ. Access should be provided to allow the finish to be applied in a controlled manner, following the manufacturer's guidelines. Generally, eye and skin protection should be worn, ventilation should be provided, and a respirator should be worn if spraying.

Most finishes require an ambient and surface temperature between 10° and 30°C for the duration of drying or curing time. Care is needed to ensure that the temperature of timber in direct sunlight is within this temperature range.

Figure 18: Site-applied pigmented deck stain requiring maintenance.

Factory

Some timber elements, wood-based building boards, windows and doors are supplied pre-primed or pre-finished. The quality of finish and level of protection offered can vary from a completely finished top coat to a temporary pre-primer. Timber products factory-supplied with a pre-primer temporary protection above a treatment, such as LOSP, should be completed on-site to the manufacturer's recommendations and would typically involve sanding the surfaces and re-priming and finishing.

The quality of final finish obtained in factory application for joinery elements is generally higher than that achievable with site application. The finish can be applied to all surfaces of elements pre-assembly, which provides a significant advantage in the assembly of joinery units. Care is required not to damage factory applied finishes in handling on-site. On-site repair work of damaged units is often below the standard achieved with the factory finish.

Factory pre-primed elements may be finished on-site with a compatible top coat without significant preparatory work other than cleaning, provided there is no evidence of deterioration of the workshop-applied coating.

5.3 Surface preparation

The purpose of preparing a substrate for finishing is to ensure that it will accept and retain the finish with the minimum of interference from surface contaminants or from previous deterioration.

The purpose of preparing a substrate for finishing is to ensure that it will accept and retain the finish with the minimum of interference from surface contaminants or from previous deterioration. The profile of the surface and its porosity will also influence adhesion of the paint system and its ultimate durability. The manufacturer's instructions should be followed in the preparation of the substrate and application of finishes in order to achieve the maximum service life from a product.

Any holes or depressions in the surface that may have occurred as a result of mechanical damage or are natural features such as resin pockets, knots, surface splits or checks should be scraped clean, primed and filled with a filler compatible with the finishing system to be used. Damaged or decayed sections should be cut out and replaced. The source of moisture should be located and the fault rectified. Adequate sealing, with sealants, water repellents or primers is essential to prevent moisture ingress into the end grain, but care should be taken not to seal moisture into the timber.

Salt contamination can quickly accumulate in buildings adjacent to the sea and must be washed off with fresh water and allowed to dry shortly before the start of work. Washing will be required each day before finishing if prevailing winds are carrying salt-laden air to the site.

New bare timber

The surface of timber can vary from a smooth (planed) surface to a sawn textured surface. The surface texture will dictate the final appearance when finished. The sawn or roughened (coarse sand papered) surface will give a more positive mechanical key to applied finishes but will result in a much thinner film on the surface peaks in the case of a film-forming finish which may lead to more rapid deterioration.

Timber with high moisture or resin/aromatic oil content should be allowed to weather for 4-6 weeks or until tanins and oils have ceased leaching before applying a film-forming finish. After weathering, timber should be lightly sanded, dust should be removed and the element cleaned before applying a finish.

The timber surface should be free from dust, grease, oil and other surface contaminants prior to finishing. It is better to avoid contamination of the surface rather than relying on cleaning; however, timber can be cleaned with specific timber cleaning products, water or spirit based cleaners. New and cleaned timber should be treated with a timber-sterilising solution before finishing in humid, tropical or mould-susceptible areas.

Previously finished timber

The preparation required for refinishing a previously finished surface will depend largely on the condition of the surface and the finish to be applied. In the case of film-forming finishes it will be necessary to remove either the entire film back to the substrate, or at least enough of it to provide a sound base for subsequent film-forming finishes if the previous finish is flaking, blistering, cracking or checking. In the case of penetrating finishes it may be possible to apply a new finish after simply cleaning the previous surface.

Manufacturers will typically recommend that all film-forming finishes which seal the surface should be removed back to bare timber, lightly sanded and cleaned with specific timber cleaning products. Surfaces previously stained or oiled should be lightly sanded and cleaned with specific timber-cleaning product.

Weathered, grey or mould–affected timber

Exposed timber which has weathered should ideally be sanded or dressed to a fresh surface before finishing if using a film-forming type finish. Penetrating type stains can be used after weathering without sanding on fresh timber.

5.4 Application

Individual products allow or prohibit certain application methods such as brush, roller, spray or pad. Suitable application methods are presented in the generic product sheets in Section 4, but should be confirmed for specific products. Penetrating finishes should generally be applied in the direction of the timber grain.

The effectiveness of an exterior finishing system is dependent on building a film of adequate thickness or providing sufficient finish for penetration, so overspreading of finishes is a false economy. The manufacturer's recommendations on thinning, surface preparation, number and sequence of coats, maximum spreading rates, weather conditions and temperature at times of application and drying, and time interval between coats, should be adhered to at all times.

The manufacturer's minimum recommended time should elapse between coats to ensure good adhesion. Care should be taken to ensure that the surface is clean and suitable for the application of subsequent coats if the time between coats is sufficient to allow for dirt to build up. The required cleaning interval between coats will vary depending on site conditions from daily, for highly polluted or coastal sites, to two weekly for sheltered sites.

Finishes should generally not be applied during extremely hot weather or when temperatures fall below 10°C. Foggy, misty or dusty weather should also be avoided. Work should be stopped early enough to allow for the film to dry sufficiently before adverse conditions develop.

5.5 Maintenance

It is difficult to predict the actual period from installation to first maintenance required for finishes because of varying exposure conditions of the site, the building, and within the element.

It is difficult to predict the actual period from installation to first maintenance required for finishes because of varying exposure conditions of the site, the building, and within the element. Areas subject to the highest exposure such as unshaded north-facing window sills may require remedial work sooner than the average product life span. Well protected elements may last three or four times longer than the exposed areas before remedial work is required. Regular visual inspection and cleaning is essential to identify areas of potential deterioration before the finish becomes compromised.

- Film forming finishes should be inspected for patchiness and thinning of the coating which are early signs of degradation and should be identified before the finish begins to flake or blister. An additional coat should be added in accordance with the manufacturer's recommendations.
- Penetrating finishes should be inspected for loss of colour or dryness, which will be evident at the early stages of degradation. Timber should be cleaned thoroughly and recoated in accordance with the manufacturer's recommendations.

Figure 19: Poorly maintained film-forming finish.

6

Fasteners

Inappropriate fastener choice will have a detrimental effect on the finishing of timber elements externally.

6.1 Introduction

This section presents key considerations in selecting suitable fasteners for timber elements in the external building envelope or decking. Inappropriate fastener choice will have a detrimental effect on the finishing of timber elements externally. Figure 20 shows the rapid deterioration of fasteners associated with the galvanic reaction of the fastener metal. The paint finish is blistered and stained as the fasteners corrode rapidly.

Figure 20: Rapid corrosion of poorly specified fasteners.

6.2 Fasteners

Fasteners should be structurally fit for purpose. Guidance can be provided by fastener manufacturers, the project engineer or, for smaller projects, the builder. Fasteners supporting external elements must resist suction (negative pressure) associated with wind loading, which will vary significantly from site-to-site and between regions, from negligible to very significant.

The durability of fasteners is influenced by the material from which they are made or the coatings applied to the fasteners, the species of the timber in which they are fixed, and their level of exposure. Galvanised steel or stainless steel fasteners are the most common types used externally. Certain timber treatments can lead to accelerated corrosion of fasteners due to galvanic reactions between the treatments and the fasteners. More durable fasteners are required in such circumstances. Guidance can be found in *EWPAA Technical Guide – Specification of fasteners* and *Wood Solutions Guide #5 Timber service life design guide: Design guide for durability.*

6.3 Detailing

Careful consideration of the placement, the number and the type of fastener is critical in fixing externally exposed timber. Externally exposed timber is subject to significant changes in moisture content and will move, expanding and shrinking with seasonal changes. Too many, overly stiff or poorly placed fasteners will restrain timber from shrinking and expanding with moisture content changes. This typically leads to splitting in the case of shrinkage, and buckling or local crushing in the case of expansion.

6.3.1 Unseasoned, ‘green’ timber

It is possible to use an appropriately durable timber species ‘green’ as well detailed external cladding but care is needed to accommodate the shrinkage that will occur as it dries to its in-service moisture content. Shrinkage in width and depth may be up to approximately 13% tangentially and is commonly between 5-7%. Subsequent shrinkage and expansion cycling with seasonal changes must also be accommodated in the fixing detail and the finishes. Examples of detailing of this type are shown in Figure 21 and Figure 22 where each cladding board is fixed with a single fastener, thus allowing movement to occur unrestrained by fasteners.

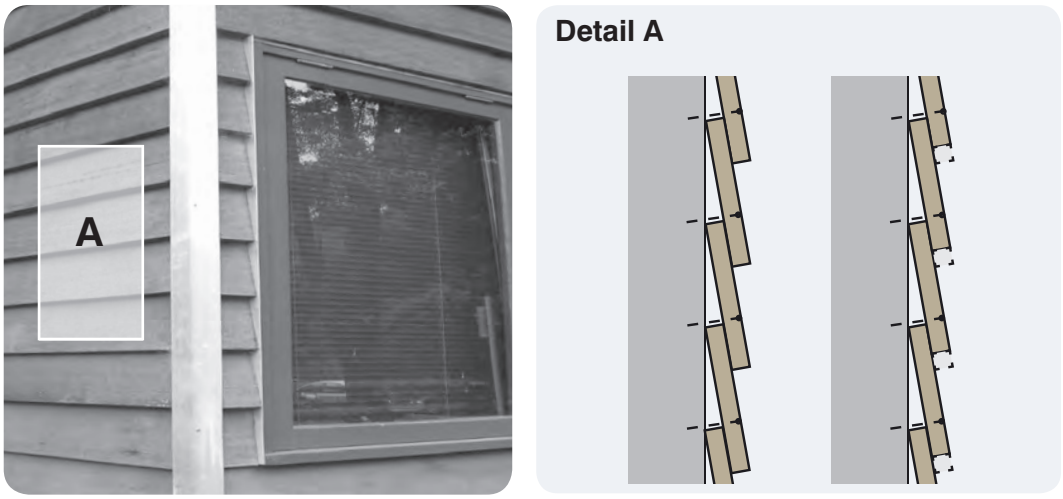

Figure 21: Detailing green timber weatherboards to allow movement.

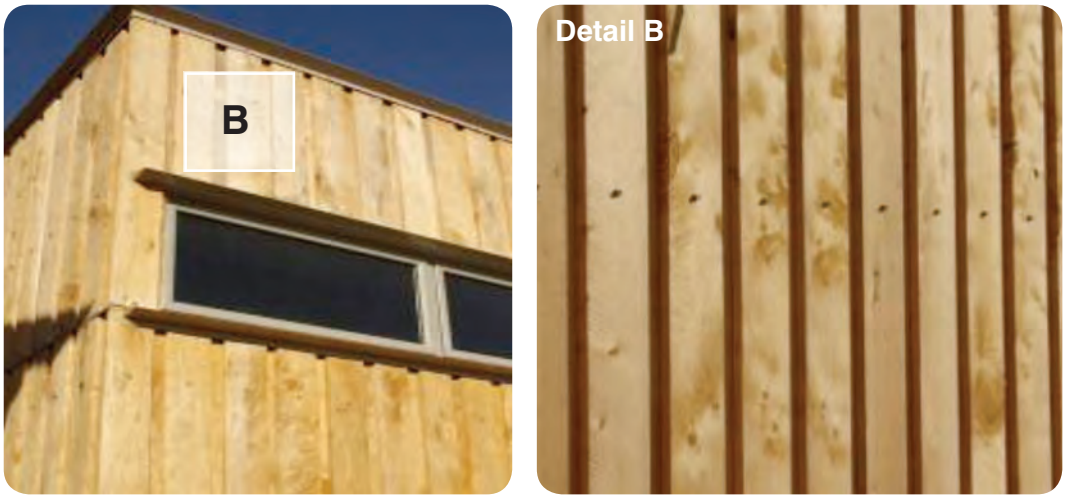

Figure 22: Visually significant fasteners; vertical green timber cladding.

6.3.2 Seasoned timber

Seasoned or ‘dried’ timber used as cladding or decking will not undergo the dramatic shrinkage in-service that occurs with green timber. However, the timber will expand and contract as its moisture content changes with seasonal variations in the surrounding environment.

Figure 23 shows a horizontally clad rain screen with semi-translucent coating and gaps between boards. A pair of stainless steel cross-head screws is used to fix the boards at regular centres along their length. The boards were dried prior to treatment and installation, so in-service movement will only be due to change in environmental conditions rather than the much larger shrinkage associated with in-situ drying. As the boards in this case are also relatively narrow, the in-service movement anticipated between the two fixings will be relatively small, so the problem of restraining the movement between the two screws is limited.

Seasoned or ‘dried’ timber used as cladding or decking will not undergo the dramatic shrinkage in-service that occurs with green timber.

Figure 23: Visually significant fasteners, seasoned horizontal cladding.

7

Selecting a finish which is appropriate for use externally on a project requires consideration of the desired design life, aesthetic requirements, durability in regional and local site conditions, timber fasteners and connections and installation and maintenance regimes.

Finish selection summary

7.1 Introduction

Selecting a finish which is appropriate for use externally on a project requires consideration of the desired design life, aesthetic requirements, durability in regional and local site conditions, timber fasteners and connections and installation and maintenance regimes. This section presents a summary of those key considerations and provides references to relevant texts.

7.2 Finish selection summary

Establish the desired design life for the element or finish

- An appropriate design life will depend on ease and cost of replacement and maintenance.
  - An element or finish which is easy to access and cheap to replace may have a short design life.
  - An element or finish which is difficult to access and expensive to replace should have a design life which matches the overall building design life.
- A building which is likely to be frequently refurbished may have elements with a design life to match refurbishment intervals.

Determine the desired surface aesthetic

- The choice of finishing system should be compatible with the timber substrate. These two factors influence the finish quality and character.
  - Machined, dressed timber elements with an opaque paint finish will result in a smooth, uniform coloured surface.
  - Rough-sawn timber with an oil or stain will allow visible grain and texture to remain with varying pigmentation.
- The quality of the surface aesthetic achieved varies with products and species. Finishing system manufacturers should be consulted for detailed information.
- Bare timber will change colour with weathering at rates varying with exposure, regional climate and species. State-based timber industry associations should be consulted for detailed information on available appropriate species.

Design measures can be used to maximise design life

- Finished elements can be effectively sheltered by an eave or overhang at 30° to the vertical.
- Elements should be detailed to shed water with sloping top surfaces, head flashings and drip lines.
- Connections and element interfaces should be designed to allow water to drain away and for ventilation to dry any residual moisture.
- Allowance should be made in the connections, fasteners, waterproofing and applied finishes for the movement anticipated in service from changing moisture content.
- Further information can be found in *Wood Solutions Guide #5 Timber service life design*.

Determine the level of hazard present

- All elements will be hazard class H3 to AS 1604-2005 but elements can be sheltered or fully exposed within H3 category. Sheltered elements are subject to less severe hazard from UV and rain.
- In bushfire prone areas AS 3959-2009 may require the use of certain timber species or intumescing finishes. *Wood Solutions Guide #4 Designing for Bushfire* provides further information.
- Buildings in areas prone to termite attack should be designed in accordance to *AS 3660.1-2000 Termite management: New building work* which may affect the detailing of the finished building envelope elements.
- Further information can be found in the *Wood Solutions Guide #5 Timber service life design*.

Select an appropriate finish, timber section and species

- Studying local precedents will provide valuable information on finishing systems and details which have been successful in similar applications.
- Finishes feature a combination of film-forming and penetrating characteristics. Film-forming finishes provide a coating over the surface and smooth out minor surface texture. Penetrating finishes follow the surface texture and grain. See product data sheets in section 5.
- Consider the desired aesthetic, the finishing system application cost, maintenance access and cost, and required finish design life. Higher initial capital costs associated with a higher quality finishing system will generally lead to lower on-going maintenance costs.
- The selected timber species should be sufficiently durable for the application. Timber can be a naturally durable species of class 1 or 2 to AS 5604-2005, or treated to H3 of AS 1604-2010.
- The selected finish should remain serviceable during the moisture movements anticipated, based on timber species or wood product used, timber section sawing and size and fastener detailing.
- The selected finishing system should be compatible with the timber species or wood product selected, the surface texture, presence of features and preservative treatments applied.
- Further information on finishing systems can be obtained from finishing system manufacturers.
- Further information on appropriate available species can be found from the state timber industry associations.

Select fasteners appropriate for the application, timber, finish and movement

- Galvanised or stainless steel fasteners should be used for treated timber to avoid excessively rapid corrosion of the fasteners due to incompatibility. Further information can be found in ***EWPAA Technical Guide – Specification of fasteners*** and ***Wood Solutions Guide #5 Timber service life design***.
- The design life of the fastener should match the anticipated design life of the element. Further information can be found in ***Wood Solutions Guide #5 Timber service life design***.
- Extractives in certain species react with fasteners of particular material leading to rapid corrosion. Fasteners should be selected to be compatible with timber species. Further information can be found in ***Wood Solutions Guide #5 Timber service life design***.
- Timber will shrink and expand in service with moisture content changes. Fasteners should be designed and specified to avoid constraining large in-service movements. A single row of fasteners parallel to the grain should be used if green timber is used or large movements are anticipated.
- Fasteners should be specified in accordance with the National Construction Code and associated standards. Structural applications should be engineer designed to ***AS 1720.1-1997 Timber structures***. ***AS 1684 Residential timber framed construction*** should be referenced for residential construction.

Develop a detailed specification for finishing system

- A detailed specification for the selected finishing system should be developed with advice from finish manufacturers and ***Species information***. Specification should include: selected finish brand, product range, colour; finish system including primer, undercoat, number of finish coats; substrate preparation; priming of joints; extra coats on sills, rails, etc; and maintenance regime.
- The specification for the timber substrate or the bare timber elements should include timber species, sustainable sourcing, timber durability class, moisture content, sawing pattern and surface finish. State timber industry associations should be consulted for more information.

Apply finishes to the manufacturer's specification

The timber substrate should be prepared in accordance with the manufacturer's instructions. Generally, timber should be clean, free from oil and grease, and free from extractives.

- The preferred method of application, whether brush, pad, roller or spray, will depend on the product used.
- Drying times between coats recommended by manufacturers should be observed. Ensure earlier coats are clean before subsequent coats are applied.

Maintain the installed system

- Bare timber elements should be inspected for signs of deterioration. Methods of ensuring water shedding and ventilation around the timber should be inspected to ensure they remain effective.
- Penetrating surface treatments should be inspected for signs of patchiness and colour-loss. Surfaces should be cleaned before additional coats are added. Finish manufacturers recommendations on maintenance and re-coating should be followed.
- Film-forming finishes should be inspected for signs of patchiness. Existing surfaces should be cleaned before new coats are added. Flaked or cracked finishes should be removed to bare timber before a new system is applied. The manufacturer's recommendations on maintenance should be followed.

8

Species information

Blackbutt, *Eucalyptus pilularis* — Australia

Name	Blackbutt
Species Name	*Eucalyptus pilularis*
Other Name	Pink blackbutt
General Availability	Readily
Source	A large hardwood common in the coastal forests of south-eastern Australia from Bega to Maryborough – native forest and plantation grown timber.

Appearance

Description	The heartwood ranges from pale cream to light yellow-brown with little difference between heartwood and sapwood. The grain is very fine and even textured. Growth rings usually visible but indistinct.

Durability

Durability Class	Outside above ground: Class 4, In-ground contact: Class 4.
Lyctis Susceptability	Not susceptible
Termite Resistance	Not resistant
Preservation	Sapwood readily accepts impregnation but the heartwood cannot be adequately treated.

Stability - Unit Shrinkage

Radial	0.18% (per 1% MC change)
Tangential	0.23% (per 1% MC change)

Physical Properties - Seasoned

Density (kg/m^3)	550
Strength Group	SD5
Joint Group	JD4
Hardness (kN Janka)	3.4 (native forest material)

Early Fire Hazard Indices

Ignitability	14
Spread-of-flame	7
Smoke-developed	2

Workability

Machining	Machines well.
Fixing	No difficulty has been experienced with the use of standard fittings and fastenings.
Gluing	As with most high-density species, machining and surface preparation should be done immediately before gluing.
Finishing	Will readily accept paint, stain and polish. High tannin and extractives content can result in staining of painted surfaces exposed to the weather.

Environmental Description

Insulation value (U)	0.22
Certification	Generally available

Fire Hazard Properties: Wall and Ceiling Lining (AS/NZS 3837)

Material Group	3
Average extinction area	Less than 250m^2/kg
Bushfire flammability	Listed as a bushfire-resisting timber in AS 3959

Hoop pine, *Araucaria cunninghamii* — **Australia**

Name	Hoop pine
Species Name	*Araucaria cunninghamii*
General Availability	Readily
Source	Hoop pine is a large tree occurring in drier rainforests from Hastings River to far north Queensland and in some places as far inland as 300 km. It is also grown in plantations, predominantly in south Queensland. While available from native forests, it is mainly a plantation timber.
General Performance	Hoop pine has traditionally been a joinery timber used for doors, window sashes and other internal and external joinery. Hoop pine is good for inside use in dry conditions. It varies in acceptance of preservative impregnation. May be attacked by the hoop pine borer in tropical areas. Can be used externally above ground if treated. Do not use in-ground.

Appearance

Description	The heartwood ranges from pale cream to light yellow-brown with little difference between heartwood and sapwood. The grain is very fine and even textured. Growth rings usually visible but indistinct.

Durability

Durability Class	Outside above ground: Class 4, In-ground contact: Class 4
Lyctis Susceptability	Not susceptible
Termite Resistance	Not resistant
Preservation	Sapwood readily accepts impregnation but the heartwood cannot be adequately treated.

Stability - Unit Shrinkage

Radial	0.18% (per 1% MC change)
Tangential	0.23% (per 1% MC change)

Physical Properties - Seasoned

Density (kg/m^3)	550
Strength Group	SD5
Joint Group	JD4
Hardness (kN Janka)	3.4 (native forest material)

Early Fire Hazard Indices

Ignitability	14
Spread-of-flame	7
Smoke-developed	2

Workability

Machining	Machines and turns well to a smooth surface.
Fixing	No difficulty has been experienced with the use of standard fittings and fastenings.
Gluing	Can be satisfactorily bonded using standard procedures.
Finishing	Will readily accept stain, polish and paint.

Environmental Description

Insulation value (U)	0.14
Certification	Generally available
Bushfire flammability	Listed as a bushfire-resisting timber in AS 3959

Jarrah, *Eucalyptus marginata* — Australia

Name	Jarrah
Species Name	*Eucalyptus marginata*
General Availability	Limited
Source	Jarrah is a dominant species in forests in south-west of Western Australia.

Appearance

Description	The heartwood is dark red. Sapwood is usually pale yellow. The grain is generally straight, moderately coarse textured and even.

Durability

Durability Class	Outside above ground: Class 2, In-ground contact Class 2.
Lyctis Susceptability	Susceptible
Termite Resistance	Resistant
Preservation	Sapwood readily accepts impregnation but the heartwood cannot be adequately treated.

Stability - Unit Shrinkage

Radial	0.24% (per 1% MC change)
Tangential	0.30% (per 1% MC change)

Physical Properties - Seasoned

Density (kg/m^3)	835
Strength Group	SD4
Joint Group	JD2
Hardness (kN Janka)	8.5

Early Fire Hazard Indices

Ignitability	13
Spread-of-flame	6
Smoke-developed	3

Workability

Machining	Machines and turns well.
Fixing	Satisfactory with standard fittings and fastenings. Some care is needed when nailing.
Gluing	Can be satisfactorily bonded using standard procedures.
Finishing	Will readily accept paint, stain and polish.

Environmental Description

Insulation value (U)	0.20
Certification	Generally available

Fire Hazard Properties: Wall and Ceiling Lining (AS/NZS 3837)

Material Group	3
Average extinction area	Less than 250m^2/kg
Bushfire flammability	Included in Table E1 of AS 3959

Messmate, *Eucalyptus obliqua* **Australia**

Name	Messmate
Species Name	*Eucalyptus obliqua*
Other Name	Australian Oak
General Availability	Limited
Source	Large hardwoods found throughout wetter areas of Tasmania, Victoria, and southern NSW. E. obliqua has a wide distribution, occurring in wet forests but also extending into drier areas.
General Performance	While external surfaces need to be painted, Messmate have performed well in timber windows and door for over a century. The timber works and finishes very well, and is readily available with environmental certification.

Appearance

Description	Colour varies from cream to pale to reddish-brown. The timber has straight, open and even grain with a texture that is open, uniform and fairly coarse.

Durability

Durability Class	Outside above ground Class 3, In-ground contact; generally Class 3.
Lyctis Susceptability	Susceptible
Termite Resistance	Not resistant
Preservation	While the sapwood can be treated, the heartwood is resistant.

Stability - Unit Shrinkage

Radial	0.23% (per 1% MC change)
Tangential	0.36% (per 1% MC change)

Physical Properties - Seasoned

Density (kg/m^3)	780
Strength Group	SD3
Joint Group	JD3
Hardness (kN Janka)	7.1

Early Fire Hazard Indices

Ignitability	14
Spread-of-flame	8
Smoke-developed	3

Workability

Machining	Moulded surfaces are true and clean, with even end grain. Holds edges well.
Fixing	Fixes well.
Gluing	Glues satisfactorily with most common adhesives.
Finishing	Readily worked to a smooth, lustrous surface. Most finishes adhere very well. Stains very well.

Environmental Description

Insulation value (U)	0.17
Certification	Generally available

Fire Hazard Properties: Wall and Ceiling Lining (AS/NZS 3837)

Material Group	3
Average extinction area	Less than 250m^2/kg
Bushfire flammability	Included in Table E1 of AS 3959

Spotted gum, *Corymbia spp* — **Australia**

Name	Spotted gum
Species Name	*Corymbia citriodora* subsp. variegata, *C. citriodora* subsp. citriodora, *C. maculata*
General Availability	Readily
Source	*Corymbia citriodora* occurs mainly in the coastal areas of northern New South Wales and southern Queensland through to North Queensland. *C. maculata* occurs from Bega to the mid-north NSW coast.

Appearance

Description	Heartwood is pale to dark brown. The sapwood is distinctly paler. The texture is moderately coarse and grain variable.

Durability

Durability Class	Outside above ground: Class 1, In-ground contact: Class 2
Lyctis Susceptability	Susceptible
Termite Resistance	Resistant
Preservation	The sapwood can be treated but the heartwood is resistant.

Stability - Unit Shrinkage

Radial	0.3% (per 1% MC change)
Tangential	0.4% (per 1% MC change)

Physical Properties - Seasoned

Density (kg/m^3)	~950 - 1000
Strength Group	SD2
Joint Group	JD1
Hardness (kN Janka)	10.1

Early Fire Hazard Indices

Ignitability	13
Spread-of-flame	3
Smoke-developed	3

Workability

Machining	Machines well due to its natural greasiness.
Fixing	Easy to work. Straight-grained material can be bent well. Unseasoned wood can be corrosive to nails and aluminium.
Gluing	Gluing can be difficult where phenolic type adhesives are used.
Finishing	Will readily accept paint, stain and polish. Has lower tannin content than most other eucalypts, therefore staining of paintwork, brickwork etc, as a result of water running over unpainted timber surfaces, is less likely to occur.

Environmental Description

Insulation value (U)	0.23
Certification	Generally available

Fire Hazard Properties: Wall and Ceiling Lining (AS/NZS 3837)

Material Group	3
Average extinction area	Less than 250m^2/kg
Bushfire flammability	Listed as a bushfire-resisting timber in AS 3959

Kwila, Merbau, *Intsia bijuga, I. Palembanica* **Imported**

Name:	Kwila / Merbau
Species Name:	*Intsia bijuga, I. Palembanica*
Other Names:	Johnstone River teak, scrub mahogany (north Queensland), merbau (Malaysia), vesi (Fiji), ipil (Philippines), melila, bendora (Papua New Guinea).
General Availability:	Readily
Source	A large tropical hardwood found from Southeast Asia to Papua New Guinea, the Philippines, Solomon Islands, Fiji and occasionally north Queensland.
General Performance	A highly durable hardwood regularly used as sills in window frames. In windows, all sides should be sealed to prevent staining of surrounding work.

Appearance

Description	Heartwood yellowish-brown or orange-brown when first cut, turning darker with age to brown or deep reddish brown. Sapwood white, pale yellow or buff and sharply differentiated from heartwood. The grain is variable but usually interlocked or wavy, texture is coarse but even. Rather greasy to the touch.

Durability

Durability Class	Outside above ground: Class 1, In-ground contact: Class 3
Lyctis Susceptability	Susceptible
Termite Resistance	Resistant.
Preservation	Sapwood only accepts preservative impregnation.

Stability - Unit Shrinkage

Radial	0.19% (per 1% MC change)
Tangential	0.30% (per 1% MC change)

Physical Properties - Seasoned

Density (kg/m^3)	830
Strength Group	SD3
Joint Group	JD2
Hardness (kN Janka)	8.6

Early Fire Hazard Indices

Spread-of-flame	0
Smoke-developed	5

Workability

Machining	Working properties variable. Cuts cleanly but may have a blunting or gumming effect on cutting edges. Cutting angle should be reduced to 20° when planing quarter-sawn stock. Turns well.
Fixing	Kwila tends to split unless pre-bored, but holds fastenings well. and fastenings.
Gluing	Glues satisfactorily except with casein glues.
Finishing	It takes paint, stain and polish well, but gum bleed-through or oily patches may affect the finish.

Environmental Description

Insulation value (U)	0.2
Certification	Occasionally available.

Fire Hazard Properties: Wall and Ceiling Lining (AS/NZS 3837)

Material Group	3
Average extinction area	Less than 250m^2/kg.
Bushfire flammability	Listed as a bushfire-resisting timber in AS 3959.

Western red cedar, *Thuja plicata* — **Imported**

Name	Western red cedar
Species Name	*Thuja plicata*
Other Names	Western cedar, red cedar
General Availability	Readily
Source	A large softwood of wet forests on the North American west coast from Oregon and Montana to British Columbia.

Appearance

Description	Heartwood varies from pale brown to dark brown. Sapwood is yellowish white. The grain is fine textured and straight grained with distinct growth rings.

Durability

Durability Class	Outside above ground: Class 2, In-ground contact: Class 3.
Lyctis Susceptability	Not susceptible
Termite Resistance	Resistant
Preservation	Sapwood is rarely present in sufficient quantities to warrant preservation. Penetration of heartwood by preservatives is negligible.

Stability - Unit Shrinkage

Radial	(~ 1.5% from green to dry)
Tangential	(~ 3% from green to dry)

Physical Properties - Seasoned

Density (kg/m^3)	380
Strength Group	SD8
Joint Group	JD5
Hardness (kN Janka)	1.5

Early Fire Hazard Indices

Ignitability	15
Spread-of-flame	10
Smoke-developed	3

Workability

Machining	Machines and turns well to a smooth surface.
Fixing	Ferrous fastenings and fittings may be corroded by wood extractives when used in weather-exposed situations.
Gluing	Can be satisfactorily bonded using standard procedures.
Finishing	Readily accepts paint, stain and polish.

Environmental Description

Insulation value (U)	0.11
Certification	Generally available.
Bushfire flammability	Not included in the tables of AS 3959

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