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PROJECT NUMBER: PR08.1062

JULY 2008

Guide to the specification, installation and use of preservative treated engineered wood products

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www.fwpa.com.au

FWPA Level 4, 10-16 Queen Street,
Melbourne VIC 3000, Australia
T +61 (0)3 9927 3200 F +61 (0)3 9927 3288
E info@fwpa.com.au W www.fwpa.com.au

Guide to the specification, installation and use of preservative treated engineered wood products

Prepared for

Forest & Wood Products Australia

by

S. Bolden and H. Greaves

Publication: Guide to the specification, installation and use of preservative treated engineered wood products

Project No: PR08.1062

ISBN: 978-1-920883-98-0

Principal Researcher/s:

Stephen A. Bolden
Holmes McLeod Consulting Engineers Pty Ltd

Dr. Harry Greaves
HG Consulting

Final report received by FWPA in July, 2008

Forest & Wood Products Australia Limited
Level 4, 10-16 Queen St, Melbourne, Victoria, 3000
T +61 3 9927 3200 F +61 3 9927 3288
E info@fwpa.com.au
W www.fwpa.com.au

PREFACE

This guide is intended to operate as an industry application document in conjunction with the suite of relevant Australian Standards and the Building Code of Australia (BCA).

The scope of this document is limited to the specification, installation and use of both untreated and preservative treated, glued EWPs, specifically including glued-laminated timber, laminated veneer lumber (LVL), plywood, oriented-strand board (OSB), particleboard and I-beams.

This document is intended to provide a user-friendly and informative guide for the best practice selection, preservative treatment, design, installation and finishing of EWPs to ensure product fitness for purpose and performance over a range of applications, hazard exposures, and design lives. The target users would primarily be designers, builders, engineers, specifiers and other users of EWPs.

In the broad sense EWP's may be taken to include a wide range of glued or mechanically joined (nail-plated) products. In the context of this publication, Engineered Wood Products (EWPs) are defined as structural timber composites formed from various timber or wood components in combination with adhesives. Nail-plated beams and trusses, and medium density fibreboard are considered outside the scope of this document. Other products such as parallel strand lumber and laminated strand lumber are not generally available in Australia and are also not within the scope of this document.

There has been a significant increase in the product range, applications and volume of Engineered Wood Products (EWPs) used in the construction industry over recent years. EWPs, including Laminated Veneer Lumber (LVL), plywood, glued-laminated timber (Glulam), strand and wood residue based products, are used in a variety of exposure hazards where treatment and or finishing systems should be used to adequately protect the product and ensure its performance over its intended life. Coupled with this is an increasing focus on the durability performance of buildings as evidenced by the ABCB publication “Durability in Building Guideline 2006”. There is a need to ensure the correct specification and application of EWPs matched to an understanding of product performance over the design life. Availability of appropriate documentation would greatly assist in addressing the commonly held misconception that EWPs can be substituted for solid timber products.

As far as authorship, Harry Greaves has written the sections covering treatment specifications and hazard classifications and Stephen Bolden has prepared the balance.

The authors wish to thank the following organisations for their contributions in the form of photographs:

- Timber Queensland Ltd
- Hyne & Son Pty Limited
- Carter Holt Harvey Wood Products Australia
- Doug Mayes (Builder)
- Egger
- Tilling Timber

Assistance of the following people is gratefully acknowledged in the preparation of this document:

- Colin Mackenzie of Timber Queensland Limited for his thoughts, comments, photographs and other constructive input
- Simon Dorries of Engineered Wood Products Association of Australasia for his review, comments and other constructive input
- Kevin Lyngcoln of Lyngco Consulting for his review, comments and other constructive input
- Sarah Postan (Holmes McLeod) for literature searches and preparation of some tables.
- Jesse Riley (Holmes McLeod) for preparation of some of the diagrams.
- Many others who have assisted in the provision of information and in the editing and review of the various drafts.

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Introduction to engineered wood products

Timber and wood products have a long history of successful use in building construction throughout Australia and around the world. More recently, the range of Engineered Wood Products (EWPs) has grown significantly in popularity and availability. Locally manufactured and imported EWPs are now widely used in Australia.

In the context of this publication, Engineered Wood Products (EWPs) are defined as structural timber composites formed from various timber or wood components in combination with adhesives. Wood components consisting of laminates, veneers, strands or flakes are reconstituted together with synthetic adhesives, usually involving heat and / or pressure, into structural sections. EWPs in Australia generally take the form of panels, rectangular sections and I-beams. EWPs gain their beneficial properties from their basic wood substrate and manufacturing techniques to optimise desirable, and minimise undesirable characteristics of wood.

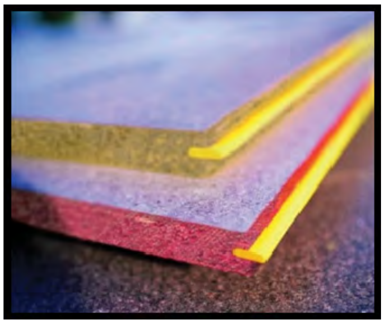
Glued-laminated timber
(Courtesy Hyne)

Laminated veneer lumber (LVL)
(Courtesy Tilling Timber)

I-beams
(Courtesy Tilling Timber)

Oriented-strand board (OSB)
(Courtesy Egger)

Plywood
(Courtesy CHH WoodProducts Australia)



Particleboard
(Courtesy CHH WoodProducts Australia)

The enormous growth in popularity of EWPs may be attributed to the many advantages over more traditional solid timber and other competing building materials. Advantages of EWPs over solid timber include:

- Greater dimensional flexibility
- Improved structural design properties and performance
- Improved dimensional stability
- More efficient use of a valuable natural resource with minimised wastage

EWPs have significant environmental advantages over other building materials such as concrete and steel, because timber is a natural, renewable resource and has a low embodied energy and acts as a carbon store when used in long term applications.

EWPs currently available in Australia include glued-laminated timber, laminated veneer lumber (LVL), plywood, oriented-strand board (OSB), particleboard and I-beams. Other products such as parallel strand lumber and laminated strand lumber are not generally available in Australia and are not within the scope of this document, but the good practices outlined in this guide may be considered equally applicable. Each of the EWPs are briefly described as follows.

Naturally durable hardwood Glulam and plywood sheathing
(Courtesy Stephen Bolden)

Glued-laminated timber, or "Glulam", is perhaps the best known and longest established of the EWPs. It is generally formed into a larger rectangular section by gluing together a number of selected and prepared solid 20 to 50mm thick timber laminates. The grain of all laminates is aligned to the longitudinal axes of the beam. Beams can be formed by either standard "face" or "edge" lamination.

Laminated veneer lumber, known as LVL, is formed by stacking and bonding together peeled or sliced veneers into a thick panel. Individual veneers are up to 6mm thick with wood grain in successive veneers generally aligned in the direction of the beam longitudinal axis. The resulting long panel is then cut into structural beam-sized sections.

Plywood is formed by stacking and bonding together a number of thin veneers to form a sheet panel product. Individual veneers are up to 6mm thick and the finished sheet up to 45mm thick. Successive veneers are laid at right angles to the previous one to form a panel with good strength in the sheet plane and good panel dimensional stability.

Oriented-strand board, known as OSB, is formed into a structural panel product by bonding together thin wood "strands" with adhesive. Wood strands are generally oriented with grain direction in the major longitudinal direction in the outer layers and in the cross direction in the inner layers of the sheet to provide panel dimensional stability.

Particleboard is formed from a mat of individual wood particles which are coated in adhesive resin and pressed together into a finished panel. Wood fibres in the particles end up randomly oriented in direction within the panel resulting in uniform properties in each direction.

Treated LVL deck bearer
(Courtesy CHH WoodProducts Australia)

I-beams are prefabricated with solid timber or LVL flanges separated and glued in place using a wood panel web. The web is most commonly plywood or OSB. The resulting cross section is a structurally efficient "I" shape.

Generic design properties of glued-laminated timber and plywood are provided in AS1720.1 Timber structures, Part 1: Design methods. Design properties for LVL, OSB, particleboard and I-beams are proprietary hence designers must specify these products by name and refer to the manufacturer for relevant design properties.

The general durability of EWPs is dependent on both durability of the timber components and durability of adhesives used to bond them. Failure of either the adhesive or wood, results in product failure. The performance of EWPs can be dramatically affected by exposure to various hazards in a "normal" building environment. In particular, exposure to insects and/or fungi can result in significant loss of section and therefore strength. Prolonged exposure of EWPs to weather and moisture can result in significant degrade of product over the medium to long term.

Buildings properly specified, designed, constructed and maintained using EWPs can be expected to provide excellent performance over the life of the structure. This document is intended to provide designers, builders and other users of EWPs with simple and appropriate guidelines to help achieve the goal of structural performance.

Treated Glulam pedestrian bridge, Ås, Norway
(Courtesy Timber Queensland)

Product selection

Correct design and specification of treated EWPs involves a number of steps as outlined in Figure 1. Each of the stated steps are presented in some detail to provide guidance to designers. Critical to the design process is the need to consider durability. This will require consideration of both the product durability and the environment in which it will be exposed during its service life.

Decorative H3 treated plywood cladding
(Courtesy CHH WoodProducts Australia)

Australia has a performance-based building regulation framework as set down in the Building Code of Australia (BCA). At this time the durability performance requirements are not directly specified, but are implicit. Durability is a key consideration for construction materials in any modern building project. According to the Australian Building Codes Board, in their guideline document Durability in Buildings,

"Durability means the capability of a building or its parts to perform a function over a specified period of time."

**Figure 1:
Design Process**

APPLICATION
Determine functional requirements for each application in the structure

↓

TARGET PERFORMANCE
Specify/list required performance:
- Performance limit states
- Lifetime
- Level of reliability
- Acceptable initial versus on-going maintenance costs

↓

HAZARD IDENTIFICATION
Determine severity of exposure hazard by considering risk of:
- Decay, Borers, Termites, Corrosion
- special considerations: chemicals or other

↓

SELECT HAZARD LEVEL
Select Hazard Level H1 – H6 for design appropriate to the biological exposure risks.

↓

PRODUCT SELECTION
Select EWP based on:
- Product suitability:
  - Wood natural durability
  - Preservative treatment level
  - Glue durability
- Product availability
- Manufacturers advice/specifications/limitations

↓

STRUCTURAL DESIGN
Size (design) members and connections for adequate structural performance

↓

DETAILING
Detailing of members and connections for:
- Aesthetics
- Shielding from weather
- Isolation from moisture
- Drainage of trapped moisture
- Adequate ventilation
- Protection from insects, incl termites
- Ease of protective coating
- Sacrificial elements or extra thickness
- Surface protective coatings
- Corrosion resistance for fasteners
- Moisture affects on member stability
- Protection from marine borers
- Ease of inspection

↓

FINISHING
Select required finishing system:
Paint, stain, water repellent, overlay, protective coating

↓

MAINTENANCE
Define maintenance and inspection regime

Expected life span

The minimum design life for buildings and components should be as shown in Table 1.

Table 1: Design life of buildings and components.

Design life of buildings (dl), (years)		Design life of components or sub-systems (years)		
		Category		
Category	No. of years	Readily accessible and economical to replace or repair	Moderate ease of access but difficult or costly to replace or repair	Not accessible or not economical to replace or repair
Short	1<dl<15	5 or dl (if dl< 5)	dl	dl
Normal	50	5	15	50
Long	100 or more	10	25	100

Notes:
1. Extracted from ABCB *Durability in Buildings*.
2. The design life of buildings should be taken as "Normal" for all building importance categories unless otherwise specified.

EWPs should be designed and installed such that the expected life span of the product exceeds the minimum required design life for the building component.

The *Timber Service Life Design Guide* (Forest & Wood Products Australia, 2007) provides detailed and extensive assistance to designers in estimating the design life of a range of solid timber components subject to Australian conditions. Quantitative modelling has been used based on research and assessment of historical performance for selected naturally durable, CCA treated and creosote treated solid timber. Designers requiring more detailed information on timber service life design should refer to the above publication.

Exposure hazard

Timber construction using EWPs is subject to a range of potential hazards during the service life of the building or structure including:

- weathering
- in-ground decay
- above-ground decay
- termite attack
- corrosion of fasteners
- marine borers
- chemical attack

Treated Glulam pedestrian bridge in full weather exposure (Elwood Canal, Melbourne).
(Courtesy Stephen Bolden)

Performance of EWPs subject to other hazards such as fire are not covered by this document and advice should be sought from other sources.

Weathering

Weathering of exposed EWPs' surfaces may result in wetting, drying, erosion and chemical changes (UV and oxygen). Unprotected wood surfaces will discolour and bleach to silver-grey due to degradative affects of washing and ultra-violet light, and then tend to dark brown or black due to the action of mildew and mould. Extremes of temperature, especially in alpine regions, can result in splitting and checking of the EWP surfaces.

Wood is hygroscopic in nature and will readily absorb and release moisture as it interacts with its environment. Repeated swelling and shrinkage of the wood surface will result from cyclic wetting and drying in response to sunlight, rain, humidity, condensation, temperature and airflow. Over time the result is mechanical damage to the wood surface in the form of checks, cracks, splits, raised grain and loose fibres. Direct erosion of the wood surface may be expected at rates between 6 to 13 mm per 100 years.

EWPs can particularly suffer from delamination (separation) around the glue-lines of individual components, laminates, veneers, strands or particles, resulting in product failure. In addition, EWPs may suffer from dimensional distortion, or movement, due to moisture content changes (refer to "Moisture affects on stability").

Degradation of EWPs due to weathering can be effectively minimised by the application and maintenance of finish coatings and by good architectural detailing (refer to "Design and installation").

Wood decay

Biodeterioration of wood, and EWPs which are essentially composed of wood, results from attack by biological organisms under favourable environmental conditions. The broad group of fungi which attack wood cells in the timber can be classified as:

- Moulds and stains (e.g. blue stain) – the main effect is on the appearance of the wood, although blue stain increases permeability and reduces impact strength.
- Rot (decay) fungi – significantly affect strength and stiffness due to break down of the cellular structure of the wood.

Four conditions are necessary to allow growth of all fungi in wood:

- Moisture – fungi will become established when the wood moisture content exceeds 30%. Some fungi continue to attack the wood at moisture contents down to 20% mc. All fungal activity ceases below 20% mc.
- Oxygen – oxygen is generally not available at levels that support most decay fungi in submerged or fully saturated wood or where it is well below ground.
- Temperatures between 5˚C and 40˚C – the ideal range is 25˚C to 30˚C.
- Food – unprotected wood provides a suitable food source of sugars and carbohydrates. The sapwood is particularly susceptible to fungi, but can be protected by preservative treatment.

Decay of untreated, non-durable Glulam beams in full weather exposure (Brisbane).
(Courtesy Doug Mayes)

Removal of one of the above four conditions will prevent decay. For the designer or user of EWPs the risk of decay may be minimised by either keeping the wood dry (<20% moisture content) or by reducing the suitability or attractiveness of the food source. EWPs may be kept reasonably dry using surface finish coatings or by good detailing to shield the wood from moisture sources. Where this is not possible, the use of naturally durable wood species or appropriate preservative treatment of the EWPs may be employed. It will not generally be possible to exclude moisture from EWPs used in ground contact. Under these conditions it will be necessary to specify EWPs made from wood components either with Natural Durability Class 1 or 2 timbers in accordance with AS 5604 *Timber – Natural durability ratings*, or preservative treated in accordance with AS/NZS 1604.2-5 *Specification for preservative treatment* (refer to "Durability and preservative treatment").

Generally, only plywood, LVL and Glulam (limited to H4) are recommended for ground contact. In-ground decay hazard zones for Australia are shown in Figure 2, and above-ground decay hazard zones for Australia are shown in Figure 3. Zone D indicates the greater hazard and zone A the lesser hazard in terms of harshness of exposure conditions and therefore risk of decay.

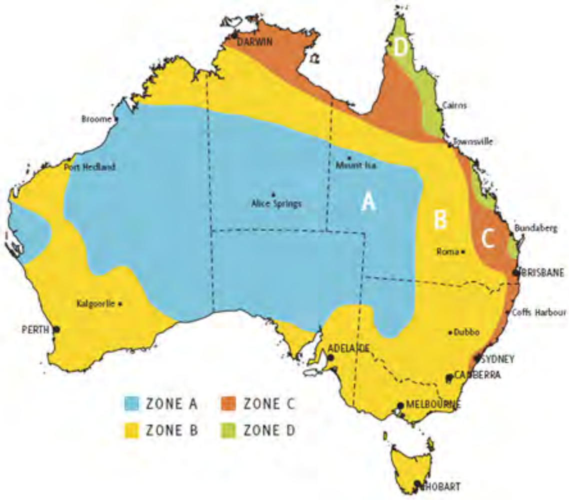


Figure 2: In-ground decay hazard zones for Australia (Zone A has least and Zone D greatest potential for in-ground decay)
Ref: Timber Service Life Design Guide, FWPA 2007

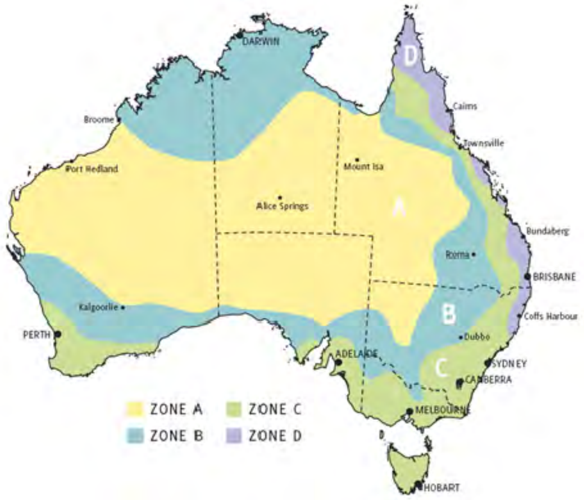


Figure 3: Above-ground decay hazard zones for Australia (Zone A has least and Zone D greatest potential for above-ground decay)
Ref: Timber Service Life Design Guide, FWPA 2007

Insect attack

The main insects of concern for EWPs in buildings are termites, lyctine beetles and furniture beetles (rarely a risk in Australia). The insect risk to timber is basically by consumption of the wood, leading to a loss of section.

Lyctus attack

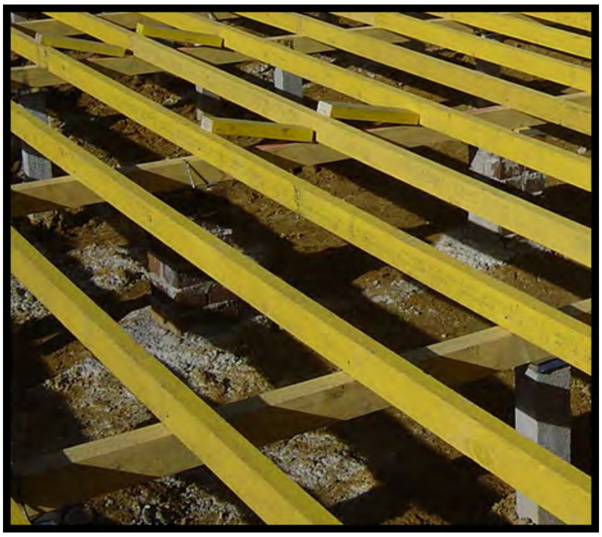
Lyctus beetles, otherwise known as powder post beetles, attack unprotected, susceptible sapwood of some hardwoods only. Susceptible species are listed in AS5604 and include spotted gum and merbau (kwila). Australian grading standards usually limit the presence of sapwood in structural sections. Protection from *Lyctus* is achieved by limiting or eliminating susceptible sapwood, or by preservative treating the sapwood to H1. Regulations (Timber utilization and marketing Acts) prevent the sale of *Lyctus* susceptible timbers containing unprotected sapwood in Queensland and New South Wales.

Furniture beetles attack older, seasoned wood. Protection is provided by:

- Climate (colder temperature regions are unsuitable to furniture beetles)
- Elevated temperatures such as unsarked roof cavities
- Enclosing EWPs within the structure
- Addition of surface films (paint, or similar)
- Preservative treatment to minimum H1.

Termite attack

Termites feed on a range of cellulose-based materials including timber. Although there are hundreds of termite species in Australia, only a few may potentially attack EWPs. The two types of termites of commercial interest for structures incorporating EWPs are drywood termites and subterranean termites.



LVL sub-floor frame treated H2 for termite resistance.
(Courtesy CHH WoodProducts Australia)

Drywood termites attack seasoned wood and do not require contact with the ground. Drywood termites tend to be difficult to detect and the damage progresses relatively slowly. Preventative measures against drywood termites generally only need to be considered in areas of highest risk in some isolated coastal areas in Queensland and in the coastal lowlands north of Cooktown. In areas at risk, protection of EWPs is best provided by use of termite resistant species (Refer AS5604) or by preservative treatment of susceptible species.

Subterranean termites are widespread throughout mainland Australia. They require contact with the ground for their water source and nests may be established below or above ground. Subterranean termites constitute by far the biggest threat to structures using EWPs. The severity of the risk posed is shown in Figure 4, indicating increased risk going from southern to northern Australia. Protection may be most simply and economically afforded to structures during construction by avoiding potential moisture traps and providing good ventilation to ensure any moisture is able to dry out of the timber. Adoption of the following practices significantly reduces the risk of termite attack:

- Isolate the timber from the ground by physical separation using non-termite susceptible materials.
- Eliminate or control cracking to concrete foundation slabs by design and installation to AS2870 *Residential slabs and footings - construction*.
- Clear the foundation soils and the general building site of wood debris.
- Avoid landscaping garden beds against the building, foundations, or unprotected timber elements.
- Eliminate untreated or un-protected termite-susceptible timber products in contact with soil.
- Install physical termite barriers and ant caps, in accordance with AS 3660.1-2000 *Termite Management Part 1: New building work*.
- Building work should comply with the Building Code of Australia (BCA), which requires protection of all structural EWPs where there is a risk of termite attack.
- Provide adequate clearance to allow inspection and ventilation of the sub-floor crawl space.
- Where ease of inspection is not possible, only preservative treated (to minimum H2) or use of only naturally termite resistant EWP components.

The designer may nominate protection, in the form of preservative treatment (to minimum H2) or use of only naturally termite resistant EWP components, in addition to other physical or chemical barriers protecting the structure. This practice is particularly advised in higher risk zones. Note that some chemical treatments and configurations in EWPs are only suitable for use south of the Tropic of Capricorn where the risk of termite attack is considered to be lower. Regular inspections to identify potential breaches of termite barriers are considered a critical part of maintenance of structures incorporating EWPs.

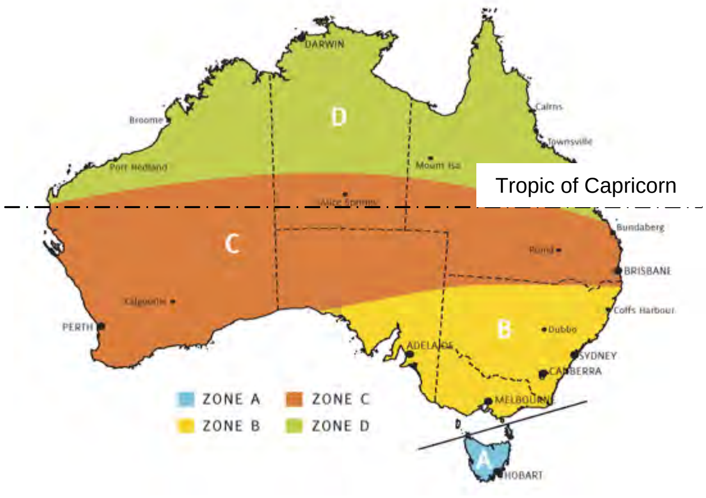


Figure 4: Termite Hazard Zones for Australia
(Zone D has the greatest termite hazard)
Reference: Timber Service Life Design Guide, FWPA 2007

Marine borers

Marine and estuarine environments present the most adverse situation for EWPs. Marine organisms are active between the high tide level and the mud line underwater. The threat is posed by bivalve molluscs and crustaceans. Molluscs damage the wood by burrowing into it for shelter and weakening it, whereas crustaceans burrow in and feed on the wood cells. As a result, chemical preservatives provide protection against crustaceans, whereas mechanical shielding tends to provide protection against molluscs. The marine borer hazard is more severe in northern waters (north of an imaginary line between Batemans Bay and Perth) and the treatment type varies accordingly for northern or southern waters. Only plywood has been recommended or allowed by AS/NZS 1604 Part 3 for treatment in marine water contact applications. Protection of EWPs may best be afforded using:

- Species with high natural resistance to marine borers, as listed in AS 5604. Only Class 1 species used in EWPs could be expected to give reasonable service life in northern waters. Few wood species have high natural marine borer resistance, therefore supply of EWPs using appropriate species is unlikely.
- EWPs impregnated with chemical preservatives to AS/NZS1604.
- Chemical and or mechanical barriers.

Chemical attack

EWPs have a definite advantage over steel members when exposed to corrosive environments. Timber and wood products are able to withstand mild acid conditions and are more resistant to degradation.

The behaviour of EWPs in chemical environments depends upon a number of factors, including timber species, pH and temperature. Wood essentially responds by either swelling (Category S), similar to moisture response, or by chemical degradation (Category D). Damage due to swelling is essentially reversible, but chemical degradation results in breakdown of the wood structure and is non-reversible. Category S agents include alcohol and other polar agents. These agents swell dry wood causing a strength (and stiffness) loss proportional to the swelling. Category D agents include acids, alkalis and salts and result in a loss of strength and stiffness directly related to the loss of member cross-section. Table 2 provides a rough guide to performance of EWPs in chemical environments.

The effect of chemicals on wood will generally be worsened by increased exposure time, temperature, extremes of pH and chemical concentration. Wood generally offers considerably less resistance to alkalies than acids. Softwoods generally have better resistance to acids than hardwoods.

Where there is the possibility of chemical attack on EWP members, designers should seek expert advice.

Table 2: Effect of chemicals on EWPs.

Agent category	Chemical agent	Mode of attack	Damage Reversible or Permanent	Severity (loss of strength and/or stiffness)
Neutral	Non-polar liquids such as petroleum hydrocarbons	None	Negligible	Negligible
S (swelling)	Alcohol and other polar solvents	Swelling	Reversible	Proportional to volumetric swelling
D (degrading)	Inorganic acids	Hydrolysis of cellulose	Permanent	Slight to moderate
D	Organic acids such as: Formic, acetic, propionic and lactic acid	Hydrolysis of cellulose	Permanent	Slight (pH 3-6)
D	Alkalis such as: sodium, calcium and magnesium hydroxide	Delignification of wood and dissolving of hemicellulose	Permanent	Moderate (pH > 9.5) Severe (pH > 11)
D	Salts (considered as weak acids)	Hydrolysis of cellulose	Permanent	Slight

Note: Ref. Williamson, T.G. (Ed) 2002

Corrosion of fasteners

The correct selection of fastener type and material is important for the long term performance of structures. Wood is slightly acidic in the range pH 3 to 6. In the presence of moisture, an acid environment is created posing a hazard for the fastener and surrounding wood material. Unprotected mild steel will corrode under these conditions and will cause a chemical reaction which also breaks down the surrounding wood.

The following measures may be employed to protect the fastener and the surrounding wood structure:

- Shield the connection from the weather and moisture.
- Use non-corrosive or protected metals (galvanised or protective coating)
- Prevent moisture traps by countersinking and plugging fasteners
- Don't use dissimilar metals in contact with each other (be aware of metals used in wood preservative treatment)
- Grease, coat or sheath fasteners to isolate from wood surface. This is particularly important where EWP components have been treated with water-borne copper treatments such as CCA, ACQ and copper azole. ACQ and Copper azole have been found to have around twice the corrosion rate of CCA.

Moisture affects on stability

EWPs, like all wood products, are hygroscopic, which means they have an affinity for water. EWPs will readily take up and release moisture in response to changes in the local environment. Most water is removed from the wood structure of EWPs during the manufacture process. Effective glue bonding requires lowered moisture content in the wood components. For example at the time of manufacture OSB has a moisture content of 2-3%, plywood about 6-8%, I-beams about 8-12%, and Glulam about 10-14%. Post manufacture and during service EWPs may be exposed to environmental conditions that cause changes in their moisture content, and therefore their dimensions.

EWPs will shrink and swell in proportion to changes in their moisture content between 0 and 30% fibre saturation point. The most significant moisture movement will occur across the grain (tangential and radial directions within a log). Longitudinal movement (in the grain direction) may be a factor depending upon the particular EWP and the type of structure. EWPs will generally be more stable than solid kiln dried timber because the process of gluing together multiple wood components tends to randomise and balance moisture responses. Warping, bow and spring may still result in response to differential moisture content.

Dimensional change:

$$\Delta D = D_i \, S \, (MC_i - MC_f) / FSP$$

where

ΔD = change in dimension
D_i = initial dimension
S = shrinkage coefficient
(Plywood = 3.5, LVL = 6.0% radial, Particleboard = 1.7% typical)
MC_i = initial moisture content
MC_f = final moisture content
FSP = fibre saturation point
(approx. 28%)

Where the possibility of wetting exists, design and detailing should allow for dimensional instability. For example, structural plywood or OSB sheathing panels should be installed with a minimum 2 mm gap around panel edges to prevent warping. Dimensional changes to EWP in response to changes to moisture content can be estimated from known shrinkage coefficients for the product and direction within the product from the equation shown above. Values of shrinkage coefficient may be obtained from the product manufacturer.

EWPs such as OSB and particleboard which are densified in the manufacture process may exhibit irreversible swelling due to cyclical moisture effects.

Glue durability

Durability of the adhesives used to manufacture EWPs is integral to the product performance. The adhesives used need permanence and non-creep characteristics to ensure performance under long term exposure. A wide variety of adhesives are available for the manufacture of EWPs. Manufacturers select adhesives appropriate for the intended applications of their products. Type I adhesives include resorcinol, phenol-resorcinol and poly-phenolic adhesives and are generally viewed as suitable for long-term, exposed applications. Type II adhesives include melamine-urea formaldehyde (MUF) and are generally viewed as suitable for long-term interior/protected applications. At the time of publication polyurethane (isocyanate) adhesive has not formally been classified, but is generally accepted as exceeding the requirement for Type II. For example structural LVL and plywood manufactured to AS/NZS4357 and AS/NZS2269 respectively are required to use Type I adhesives (Type A bond - permanent). Other EWPs may use Type I or II or other adhesives depending upon the intended application. Type I adhesives are generally suitable for applications where there is full exposure to weather and where there may be prolonged exposure to high temperatures (>50˚C). They have demonstrated excellent long term performance in the field in excess of 50 years in plywood and glued-laminated timber. When cured, Type I adhesives are waterproof, are not attacked by biological organisms and do not soften or melt at high temperatures. Type II adhesives are generally suitable for applications where there is protection from the weather and temperatures ≤50˚C. The climatic equivalent in terms of wood moisture content is relative humidity ≤ 85% at 20˚C. It is important for users to check with manufacturers as to the suitability of their EWPs, and the relevant adhesive, for the intended application. Table 3 indicates glues commonly used in the manufacture of various EWPs.

Table 3: Adhesives commonly used in the manufacture of EWPs

EWP type	Manufacturing standard	Adhesives Commonly used for manufacture
Glued-laminated timber	AS/NZS 1328.1	Type I (usually) Type II (permitted)
Laminated veneer lumber (LVL)	AS/NZS 4357[1]	Type I
Plywood	AS/NZS 2269[1]	Type I
Oriented-strand board (OSB)	Overseas standards e.g. EN300	Type II
Particleboard	AS/NZS 1860.1	Type II
I-beams	Proprietary	Depends upon components

Note:
1. Indicates Type I (Type A bond) is mandatory under the manufacturing standard.
2. "Proprietary" indicates information may be obtained from the manufacturer.

In the event of incorrect product selection in regard to bond durability type, EWPs can suffer delamination around the glue lines of individual components, laminates, veneers, strands or particles, resulting in product failure. Appropriate adhesive types, bond durability and quality requirements relative to the intended application or exposure, are detailed in the relevant Australian / New Zealand Standard for each product type.

Product durability

Product durability of EWPs is a function of a number of factors including the combined inherent durability of the wood and glue components comprising the product, applied preservative treatment, finishes and coatings to product, design and detailing of structure, on-going maintenance practices, and the environmental exposure hazards. Due to the complexity of the range of factors, design for durability and accurate prediction of durability performance including service life is difficult. Although this document provides broad guidance to the designer on selection and use of EWPs in the range of hazard environments, readers should refer to the Timber Service Life Design Guide (FWPA 2007) for more comprehensive assistance with prediction of service life. The Timber Service Life Design Guide is intended for use with solid timber products and is not specifically applicable to EWP's, so should be used with caution.

Structural requirements

Structural design of EWPs is carried out in accordance with AS1720.1 *Timber structures – Part 1: Design methods*. This standard specifies the design methods, criteria and mechanical property requirements for traditional sawn timber and some EWPs. The source of design properties and some design criteria varies depending on the type of EWP as shown in Table 4. The AS1684 *Residential timber-framed construction* series is a building application standard specifically for domestic and similar construction. An extensive list of design criteria, models and deflection criteria are provided in AS1684.1 and have been used by industry associations and EWP manufacturers to prepare span tables and software design tools. Both AS1720.1 and AS1684 (Parts 2, 3 and 4) are primary referenced Standards to the Building Code of Australia.

Table 4: Source of structural design properties and criteria for EWPs

EWP type	Manufacturing standard	Design properties	Design factors/criteria
Glued-laminated timber	AS/NZS 1328.1	AS 1720.1, or Proprietary (limited)	AS 1720.1 and GLTAA
Laminated veneer lumber (LVL)	AS/NZS 4357	Proprietary	AS 1720.1
Plywood	AS/NZS 2269	AS 1720.1	AS 1720.1
Oriented-strand board (OSB)	Overseas standards e.g. EN300	Proprietary	Proprietary
Particleboard	AS/NZS 1860.1	Proprietary	Proprietary
I-beams	Proprietary	Proprietary	Proprietary

Note:
1. “Proprietary” indicates information may be obtained from the manufacturer.
2. GLTAA refers to Glue Laminated Timber Association of Australia

Connections

Table 5: Selecting Corrosion Resistant Fasteners

Material	Applications	Remarks
Stainless Steel 304	Chemical, Industrial and Marine	Grade 316 is preferred for marine environments. Additional protection via coatings should be applied to grade 304.
Monel	Marine	Usually used in boat building, nails/ screws available.
Silicon Bronze, Copper, Brass	Marine	Usually used in boat building, nails and screws available. Do not use in contact with aluminium. Nails also available for acidic species, i.e. western red cedar cladding.
Hot Dipped Galvanised and Mechanically Plated	External exposed to weather and low corrosivity. Industrial and marine environments.	Where in contact with moist CCA treated timber, additional protection using plastic sheaths or bituminous or epoxy coatings are suggested for bolts. Other protective coatings can be applied to other types of connectors.
Plated (Zinc, Cadmium) and Gold Passified	Internal exposed to view or protected from the weather and corrosive gases.	Care required with handling and installation to avoid damage of the protective coating.
Mild Steel	Fully protected from the weather, moisture or corrosive gases.	Use zinc dust paint systems to provide a base for conventional paints.

NOTE:
1. Materials have been listed in descending order or resistance to corrosion
2. Life expectancy of zinc coatings is determined primarily by the weight or thickness of the zinc. As a minimum, hot dipped galvanised fasteners should have a coating thickness of 42 microns. This thickness is not normally achieved with zinc coatings applied to typical light metal fasteners made from sheet steel.
3. Reference: Timber Service Life Design Guide, FWPA 2007

Connections must be properly designed and detailed to ensure the required durability performance for the intended service life of the structure. The following factors require consideration in the design of connections:

- Selection of the appropriate fastener material should be based on Table 5, depending upon the application and resulting hazards. Selection of the appropriate fastener will minimise the potential corrosion of fasteners and breakdown of the wood around the fastener.
- The treatment type in the wood will influence the corrosion rate of the connector material according to Nordic and North American research. Generally research has shown that the corrosivity of copper azole is similar to CCA (copper chromium arsenic) while the corrosivity of ACQ (ammoniacal copper quarternary) is approximately double that of CCA. As such, the use of stainless steel in preference to hot-dip galvanised connectors is recommended in conjunction with ACQ treated wood where there is a risk of elevated moisture content in the wood.
- Connection design needs to accommodate or restrain any potential movement in the joint from moisture induced shrinkage and swelling of the EWPs.
- Minimise moisture traps and horizontal contact areas where moisture may enter.
- Connection capacity values for a range of standard fasteners are provided in AS1720.1 for solid timber, Glulam, plywood and LVL. Designers will need to refer to proprietary information on connection capacities of OSB and particleboard.

More detailed guidance on connection durability design in timber is provided in the Timber Service Life Design (FWPA 2007).

Selection guide

Table 6 provides a guide for designers for selection of appropriate Hazard Class and suitable EWPs for a wide range of typical applications. EWPs in exposed applications (H3 and higher hazards) must be protected by an appropriate combination of architectural detailing, surface finishing and a maintenance program. Regardless of preservative treatment, OSB and particleboard products are not currently recommended for long term exposure to H3 or higher hazards.

Table 6: EWP selection chart

Product application	Sub-application	Hazard class	Suitable products
Beams	Interior	H1, H2	I-beams, Glulam, OSB, Plywood, LVL
	Exterior	H3	Glulam, Plywood, LVL
Boat building	Deck &superstructure	H4	Plywood
	Hull	H5, H6	Plywood
Bus floors		H3	Plywood
Cladding		H3 A	Plywood, LVL
		H3	LVL
Compost bin		H3, H4	Plywood, LVL
Cooling tower	Structure	H5	Plywood, LVL
Decking	Bridge	H3, H4, H5	Plywood, LVL
	Wharf	H3, H4, H5	Plywood, LVL
	Patio	H3	Plywood
Drain linings		H5	Plywood
Fascia board		H3 A	Plywood, LVL
		H3	LVL
Flooring	Interior	H1, H2	Plywood, OSB, particleboard
	Exterior	H3	Plywood
Framing	Interior	H1, H2	I-beams, Plywood, OSB, particleboard, Glulam, LVL
	Exterior	H3	Plywood, Glulam, LVL
		H3 A	LVL
	House – Wall – Subfloor	H2	I-beams, Plywood, OSB, particleboard, Glulam, LVL

Product application	Sub-application	Hazard class	Suitable products
Glasshouse products		H3, H3 A	Plywood, Glulam, LVL
		H4	Plywood, Glulam, LVL
Horticultural products		H3	Plywood, Glulam, LVL
		H3 A	Plywood, LVL
		H4	Plywood, Glulam, LVL
		H5	Plywood, LVL
Joinery – Exterior		H3	Plywood, Glulam, LVL
		H3 A	Plywood, LVL
Landscape product		H4	Plywood, LVL, Glulam
Lattice	Exterior	H3, H3 A	Plywood
Light standards		H4	LVL, Glulam
Linings	Interior	H1, H2	Plywood, OSB, particleboard
	Exterior	H3, H3 A	Plywood
Noise barriers	Above ground	H3, H3 A	Plywood, LVL, Glulam
	Ground contact	H4	Plywood, LVL, Glulam
Pergola products	Above ground	H3, H3 A	Plywood, LVL, Glulam
Pontoons		H6	Plywood
Posts	Interior	H1, H2	Glulam
	Exterior (above ground)	H3	Glulam
Seed boxes		H4	Plywood
Shingles		H3	Plywood
		H4, H5	Plywood
Signs	Exterior	H3, H3 A	Plywood
Spa pools		H4	Plywood
Staircases	Interior	H1, H2	LVL, Glulam
	Exterior (above ground)	H3	LVL, Glulam
Verandah	Floors	H3	Plywood, LVL, Glulam
	Supports – above ground	H3,H3 A, H4	Glulam, LVL
	Supports – in-ground	H5	LVL

NOTE:
1. The above Table is based on AS/NZS1604 series of standards
2. OSB and particleboard are not generally recommended or available as H3 treated in Australia.
3. EWPs in exposed applications (H3 and higher hazards) must be protected by an appropriate combination of architectural detailing, surface finishing and a maintenance program.

Durability and preservative treatment

Natural durability and preservative treatment

Some timber species are naturally durable due to the presence of natural constituents, known as extractives, in their heartwood (inner part of the log). Natural durability classifications for the range of available untreated timbers are given in AS 5604 *Timber – Natural durability ratings*. These ratings are for:

- Decay in-ground
- Decay above-ground
- Lyctus susceptibility
- Termite resistance

- Marine borer resistance.

AS 5604 defines the natural durability rating as the inherent resistance of the heartwood of a timber species to those hazards. For example the heartwood of spotted gum, merbau (kwila) and cypress pine are resistant to termite attack and outside, above-ground decay. AS 5604 provides a guide to probable life expectancies for each natural durability class.

EWPs may exhibit varying levels of natural durability depending upon the timber species employed in the components. Unless the constituent wood fibre for the EWP is from naturally durable timber species, the particular product will have low natural durability. Since non-durable softwood fibre is the main feedstock for EWPs in Australasia, and also some hardwoods are used that are not usually naturally durable, most EWPs must be made durable by the selective application of preservative treatment. Untreated sapwood of all timber species is regarded as non-durable with respect to decay and susceptibility to termite attack.

The preservative chemicals and specifications for their use in EWPs and in solid timber are set down in a suite of Australasian standards, the AS/NZS1604 series.

Natural durability class 2 hardwood Glulam sign post.
(Courtesy Stephen Bolden)

Table 7: The wood preservation specification standards used in Australia and New Zealand

AS 1604	**Specification for preservative treatment**
AS 1604.1	Part 1: Sawn and round timber
AS/NZS 1604.2	Part 2: Reconstituted wood-based products
AS/NZS 1604.3	Part 3: Plywood
AS/NZS 1604.4	Part 4: Laminated veneer lumber (LVL)
AS/NZS 1604.5	Part 5: Glued-laminated timber products

EWPs are used in a variety of applications and the choice of preservative system, if required, is influenced by the service exposure conditions and also by the manufacturing process. Where the timber substrate used to manufacture the EWP is of a naturally durable species, e.g. glued-laminated timber (Glulam) made from spotted gum, merbau, cypress pine etc. preservative treatment may not be required and/or the preservative specification will be adjusted accordingly (see "Treated EWPs"). Note that "reconstituted wood-based products" (RWBPs) include particleboard and OSB.

It is the responsibility of the designer / specifier to assess the hazard to which the EWP will be exposed and then to specify the required Hazard Class for the EWP performance for the particular application. For example, "plywood bracing panels to meet Hazard Class H2". It is the responsibility of the

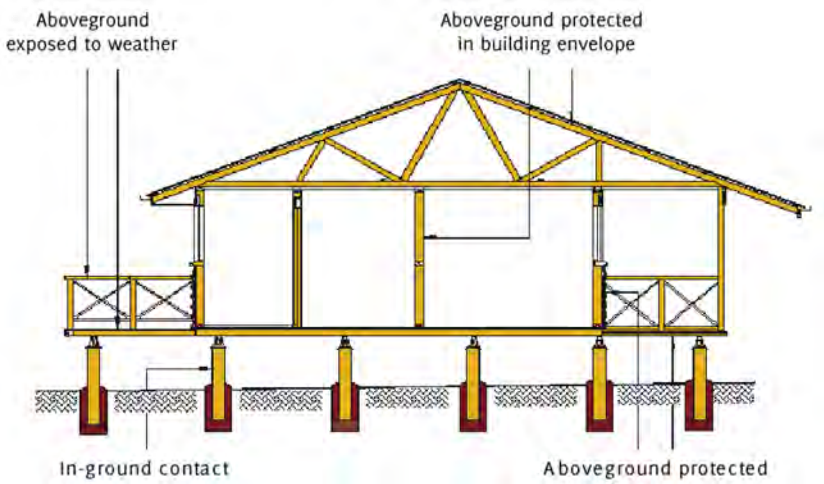


Figure 1: Weather Exposure (See Figure 7 for further explanation of weather exposed)
Reference: Timber Service Life Design Guide, FWPA 2007

product supplier to ensure the EWP complies with AS 1604 and will perform adequately for the particular Hazard Class. The performance requirements for the EWP may be met by a combination of natural durability and / or a prescribed preservative treatment in terms of type, retention level and mode of treatment as specified in the AS 1604 series and State legislation.

Hazard classification

The primary in-service hazards to which EWPs may be subject are biological in nature, i.e. wood borers, termites, and decay fungi, and are identified by a Hazard Class number, as shown in Table 8. Weather also can degrade EWPs but, while some preservatives may confer a degree of weather resistance, this is usually achieved by architectural or finish detailing, e.g. shielding or an effective paint system. Table 9 shows typical uses for EWPs against the six Hazard Classes. These Hazard Classes are further defined and described in the AS/NZS1604 series of standards.

Table 8: Description of Hazard Classes

Hazard class	Exposure	Specific service conditions	Biological hazard
H1	Inside, above ground	Completely protected from the weather and well ventilated, and protected from termites	Lyctid borers
H2	Inside, above ground	Protected from wetting and with no leaching	Borers and termites
H3	Outside, above ground	Subject to periodic moderate wetting and some leaching	Moderate decay, borers and termites
H4	Outside, in-ground	Subject to severe wetting and leaching	Severe decay, borers and termites
H5	Outside, in-ground contact with or in fresh water	Subject to extreme wetting and leaching and/or where the critical use requires a higher degree of protection	Very severe decay, borers and termites
H6	Marine waters	Subject to prolonged immersion in sea water	Marine wood borers and decay

H2 treated I-beam with finger jointed flanges & OSB webs
(Courtesy Hyne)

Further possible uses of EWPs are listed later in Table 6 and in all parts of AS/NZS1604 series as Appendix A, which is a guide to the hazard classifications for various commodities.

Where the EWP is a composite product of two different components, e.g. I-beams made with LVL flanges and plywood webs, or finger-jointed solid timber flanges and OSB webs, each component is considered as a separate entity for the purposes of preservative specification.

Detailed preservative specifications for EWPs are listed in the appropriate parts of the AS/NZS1604 series. In this document they are given in the section "Treated EWPs" and Appendix A. Note that both the list of approved preservatives and their detailed specifications are revised at regular intervals and the reader must always refer to current versions of the standards.

Table 9: Typical uses of EWPs

Hazard class	Typical uses	Engineered Wood Product
H1	Flooring, furniture, interior joinery Wall bracing, Interior beam webs Interior beam flange, staircases, stringers Beams, joists, rafters, lintels	OSB, particleboard, plywood OSB, particleboard, plywood LVL, Glulam I-beams, LVL, Glulam
H2	Flooring, dry areas Wall bracing, Interior beam webs Interior beam flanges, staircases Framing, beams, joists, rafters, lintels	OSB, particleboard, plywood OSB, particleboard, plywood LVL, Glulam I-beams, LVL, Glulam
H3	Flooring, damp areas, cladding Exterior decking, exterior beam webs Exterior beam flanges Posts	OSB, particleboard, plywood plywood LVL, Glulam Glulam
H4	Flower boxes, sound barriers Bridges, foundation structures Light standards	Plywood LVL, Glulam Glulam
H5	Cooling tower structures, Pontoon decks Retaining wall, foundation, pile structures	Plywood, LVL LVL
H6	Pontoon landing steps and similar	Plywood

Preservative treatment methods

EWPs can be treated either prior to gluing in their make-up form – the particles, veneers, laminates – or as a made-up finished and glued product. Preservatives are delivered to the fibre feedstock, to the adhesives used in manufacture, or to the final finished product. The treatment method is coded in the standards and should form part of the treated EWPs brand mark. Table 10 describes the designated treatment patterns. Table 11 summarises these EWP treatment designations for the various hazard classes.

Table 10: EWP treatment methods

Code	Penetration Pattern Type
P	Fibre particles have been treated
V	Veneer treatment
E	Envelope treatment of the finished product
G	Gluelines have been dosed with biocide
G/F	Gluelines have been dosed plus the face layers/veneers have received treatment
T	Solid timber laminates have been treated before fabrication

Table 11: EWP treatment designations for various hazard classes

EWP type	Treatment designation					
	H1	H2	H3	H4	H5	H6
OSB, particleboard	P	P, E, G, G/F	P, E	-	-	-
Plywood	V, G	E, V, G, G/F	E, V	E, V	E, V	V
LVL	V, G	E, V, G, G/F	E, V	E, V	E, V	-
Glulam	T	T, E	T, E	T, E	-	-

For each Hazard Class, there can be a range of preservative types and modes of treatment permitted under AS/NZS 1604 series. Each combination does not necessarily confer equivalent performance. For example, H3 CCA treated softwood will generally be regarded as more robust than H3 light organic solvent preservative treated softwood, in terms of treatment durability.

Treated EWPs

Detailed specifications for the preservative treatment of EWPs for each of the six hazard Classes are given in the AS/NZS 1604 series and in relevant State legislation. The information of particular relevance to treated EWP suppliers including the current preservative types, designations and retentions (%m/m) is also provided for information in Appendix A in Tables A1 to A6. General information about preservative treatments is provided below for designers, specifiers and users of treated EWPs.

H1 products

H1 products are required to resist attack from Lyctid **borers** experienced in **inside, above-ground** exposure. All EWPs are generally available to suit H1 Hazard Class applications by means of either natural resistance or by preservative treatment.

All Lyctus-susceptible hardwood sapwood must be treated. In the case of OSB and particleboard the fibre particles should be <3 mm thick. For plywood and LVL, all susceptible veneers should be treated, and for Glulam the susceptible sapwood should be treated.

Note that the requirement to treat Lyctus-susceptible hardwood sapwood applies to all other hazard classes, in addition to their other requirements. Softwoods are Lyctus non-susceptible. More detailed information on preservative treatment of EWPs to H1 level is provided in Appendix A1.

H2 products

H2 products are required to resist attack from **borers** and **termites** experienced in **inside, above-ground** exposure. All EWPs are generally available to suit H2 Hazard Class applications by means of either natural resistance or by preservative treatment.

Inadvertent weather exposure of H2 treated EWPs may compromise the integrity of the preservative treatment. Users need to be cautious to limit weather exposure of H2 treated EWPs during storage and construction to a maximum of 3 months, or as otherwise specified by manufacturers. More detailed information on preservative treatment of EWPs to H2 level is provided in Appendix A2.

H3 products

H3 products are required to resist attack from **borers, termites** and **moderate decay** experienced in **outside, above-ground** exposure. EWPs, including plywood, LVL and Glulam are generally available to suit H3 Hazard Class applications by means of either natural resistance or by preservative treatment.

Particleboard and OSB treated to H3 are not currently available in Australia, although specifications are provided in AS/NZS 1604 series. More detailed information on preservative treatment of EWPs to H3 level is provided in Appendix A3.

H4 products

H4 products are required to resist attack from **borers, termites** and **severe decay** experienced in **outside, in-ground** exposure. EWPs, including plywood, LVL and Glulam are generally available to suit H4 Hazard Class applications by means of preservative treatment.

OSB and particleboard are not specified (or recommended) in AS/NZS 1604 SERIES for H4 exposure conditions. More detailed information on preservative treatment of EWPs to H4 level is provided in Appendix A4.

H5 products

H5 products are required to resist attack from **borers, termites** and **very severe decay** experienced in **outside, in-ground** contact with, or in, fresh water exposure. Generally only plywood and LVL EWPs are available to suit H5 Hazard Class applications by means of preservative treatment.

OSB, particleboard and Glulam are not specified (or recommended) in AS/NZS 1604 SERIES for H5 exposure conditions. More detailed information on preservative treatment of EWPs to H5 level is provided in Appendix A5.

H6 products

H6 products are required to resist attack from **marine wood borers** and **decay** experienced in **marine water** exposure. Only plywood EWPs are available to suit H6 Hazard Class applications by means of preservative treatment.

Plywood is the only EWP currently specified in AS/NZS 1604 SERIES for H6 marine exposure. Only two preservatives are allowed and they are used either in combination as a double-treatment or singly, depending on the region of exposure. More detailed information on preservative treatment of EWPs to H6 level is provided in Appendix A6.

Regulatory and practical limitations

The approved preservatives listed in AS/NZS 1604 series have been registered for use by the Australian Pesticides and Veterinary Medicines Authority (APVMA) and/or the Environmental Risk Management Authority (ERMA) of New Zealand. In addition, preservatives that have been registered for use in other countries and that have not been disallowed for use in Australasia may also be approved for local use. This is provided the treatment satisfies appropriate regulatory requirements such as the Timber Market Act (NSW) and the Timber Utilisation and Marketing Act (Qld) and the requirements of the Building Code of Australia as an approved Alternative Solution.

The APVMA has restricted the use CCA for the treatment of some timber products that may come into frequent and intimate human contact. This includes timber intended for use as garden furniture, picnic tables, exterior seating, children’s play equipment, patio and other domestic decking boards, and handrails. All other timber may continue to be treated with CCA, but these products are required to be marked with the words “Treated with Copper Chrome Arsenate” as well as the other brand requirements that are set down in the AS/NZS 1604 series and State legislation in NSW and Queensland.

Treated Glulam light standard
(Courtesy Harry Greaves)

The specifications for some tin-based LOSP treatments for Hazard Class H3 are influenced by the end use situation: for structural commodities used predominantly in a horizontal exposure situation the tin retention is twice that required for non-structural commodities that are painted and used vertically exposed, e.g. window joinery, fascia, bargeboards, cladding.

It is good building practice to utilise preservative treated commodities with as little damage to the treatment zone as is practically possible, i.e. damage caused by ripping, cross-cutting, shaping, boring, machining, etc. This is particularly important in the case of treated EWPs, where an envelope treatment has been used. If such post-treatment actions are unavoidable and the treated envelope is breached, a brush-on or similar supplementary wood preservative remedial treatment must be applied to the damaged surfaces. These types of remedial treatments are readily available from preservative suppliers. Some acceptable supplementary treatments are given in “Working with EWPs”.

Design and installation

Good design and detailing

Architectural and structural detailing are critical in ensuring durability performance when considering the effect that weathering, exposure, moisture and termites can have on EWPs in a building. Poor design and detailing can potentially wipe many years off the service life of a structure and significantly increase the cost of maintenance. Geographical location, climate and building orientation can significantly affect the interaction of the building and its environment and should be considered in the planning and design process. Good design and detailing of EWPs, usually most critical around joints, must consider the following key factors:

- Shielding
- Isolation
- Drainage
- Ventilation

Good design and detailing for EWPs is shown in Figures 5 to 12.

Beams protected from weather by capping, back-cutting and painting (Lahti, Finland).
(Courtesy Timber Queensland)

Exposed Glulam beams protected from weather using metal end capping (Breakfast Creek Pub, Brisbane).
(Courtesy Stephen Bolden)

Shielding

Shielding works by blocking or deflecting weather and moisture from direct contact with the EWP structure. Shielding can involve the use of gross screening of the structure with vegetation or by using fences, pergolas, or the like to provide some protection from direct exposure to the elements. Care is necessary to ensure moisture build-up does not occur due to poor ventilation. Other more specific physical shielding systems for structures include:

- Substantial roof overhangs
- Capping and flashing
- Fascias and barges

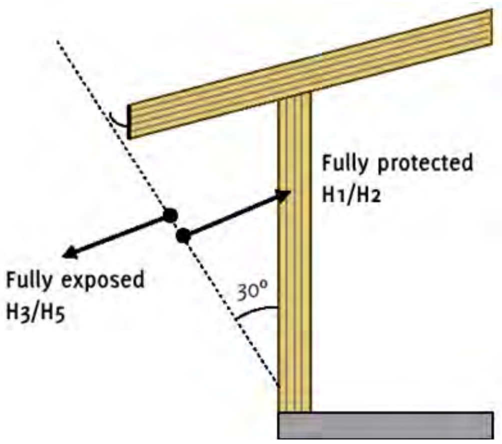


Figure 5: Architectural Detailing – Shielding
Reference: Timber Service Life Design Guide, FWPA 2007

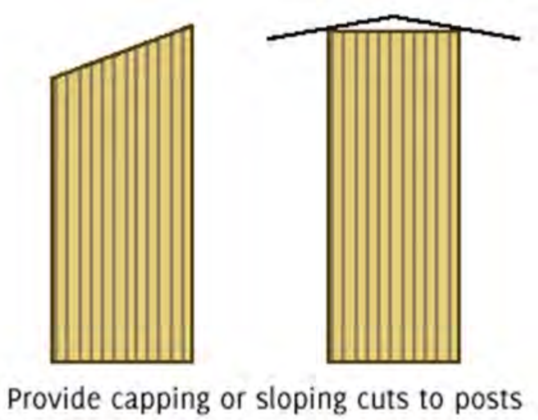


Figure 6: Weather Protection
Reference: Timber Service Life Design Guide, FWPA 2007

Damp proof course strip above H3 treated LVL deck joists to isolate from decking and weather (Maryborough)
Courtesy Stephen Bolden

Roof overhangs are regarded as particularly useful in providing physical shielding of buildings from the weather. The building zone in side the 30˚-from-vertical line under a roof overhang is commonly accepted as being protected from weather exposure (i.e. H1/H2 when above ground). One of the most common and easiest forms of shielding is the application of damp proof course (DPC) above decking joists and under the decking boards. This relatively simple measure can add at least 5 to 10 years to the service life of exposed decking joists.

Naturally durable hardwood Glulam post isolated from ground
(Courtesy Holmes McLeod)

Isolation

Isolation of EWPs involves separation from moisture sources, moisture traps, or direct contact with other exposed or potentially damp members. Isolation of members or connections can be achieved by:

- Building in air gaps to prevent bridging of water
- Damp-proof courses
- Sarking

Drainage

EWP members and connections should always be designed to allow free drainage of water. Where possible slope or profile top

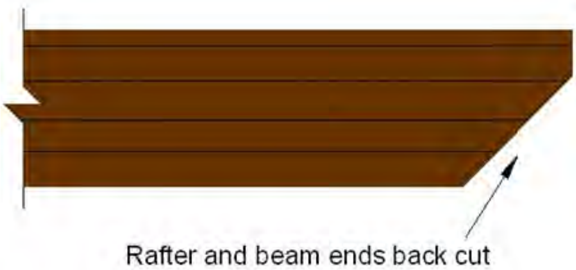


Figure 8: Back cut rafter / beam overhangs

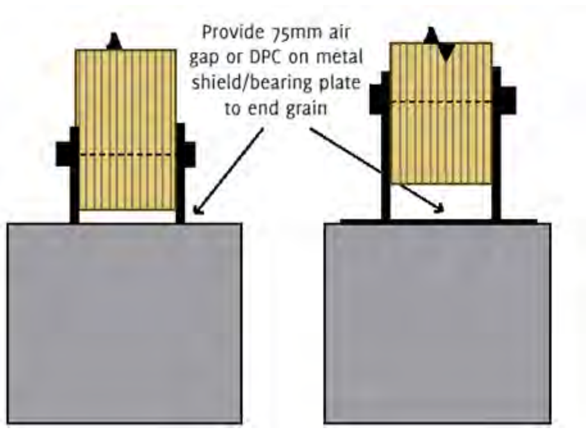


Figure 7: Isolation of Timber from Moisture Traps
Reference: Timber Service Life Design Guide, FWPA 2007

Treated Glulam and plywood structure isolated from ground
(Courtesy Harry Greaves)

surfaces or provide drainage holes to prevent water sitting on the surface.

Ventilation

Ventilation is essential to prevent moisture accumulation from a variety of sources including rain, leaky plumbing, rising damp from foundation soils and condensation. Rising damp under sub-floors is handled by building regulations which specify minimum cross-flow ventilation.

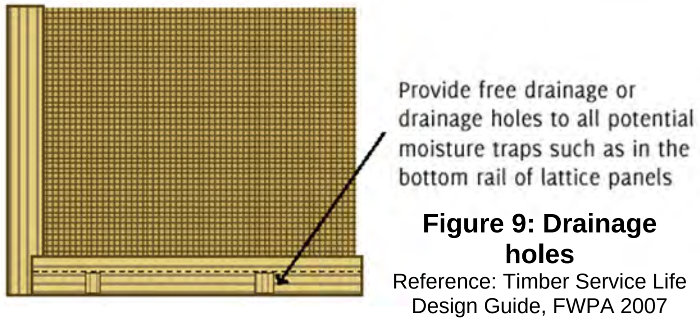


Figure 9: Drainage holes
Reference: Timber Service Life Design Guide, FWPA 2007

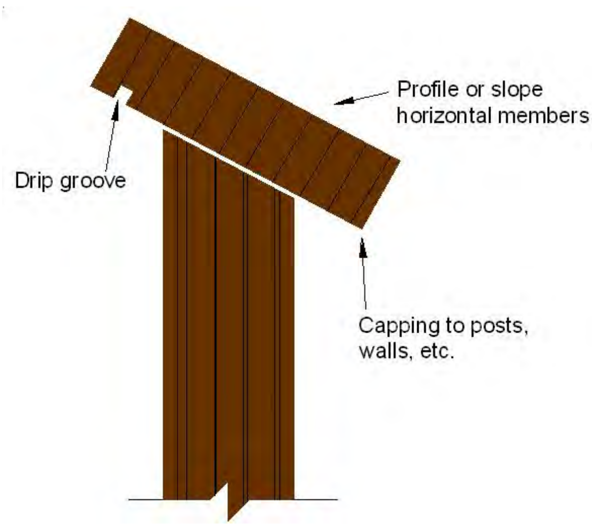


Figure 10: Slope horizontal members

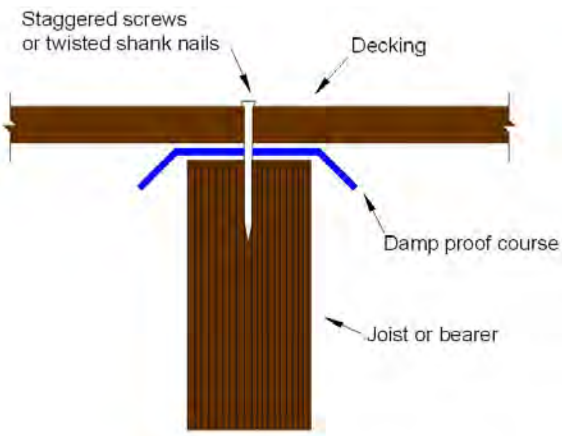


Figure 11: DPC to isolate joists

Figure 12: Beam capping / end flashing

Condensation occurs when warm, moist air is cooled to the dew point temperature, and will usually occur in contact with cool surfaces within a building. Condensation will most often occur in external wall and roof spaces where there is likely to be a high temperature difference between the exterior and interior of the building envelope. In cold climates moisture may condense onto cladding, sheathing, framing, flooring and ceilings as warm, moisture-laden air within the building seeks to escape. In warm climates where air conditioning is employed, the opposite can occur with warm moisture-laden air migrating into the building envelope.

Measures to reduce the risk of condensation in a building include:

- In cold climates maintain a relatively constant heating cycle for the building.
- Install adequate room ventilation, particularly in kitchens, bathrooms and laundries where higher temperatures and humidity may occur. Ventilation fans are advisable.
- Vapour barriers and sarking can be used to restrict the movement of water vapour in air. Vapour barriers should be installed on the warm side of the wall (insulation).

Things to avoid

- Moisture traps – avoid timber enclosed in "shoes" where water cannot escape.
- Untreated, non-durable EWPs exposed to the weather.
- Condensation build up
- Horizontal contact areas – minimise all horizontal contact areas (Refer to Figure 13)
- Horizontal exposed surfaces – I-beams are generally not recommended for use where water may accumulate on flanges as it can degrade wood around the web-flange interface

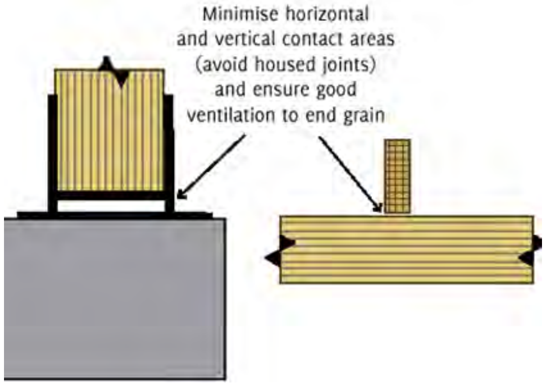


Figure 13: Moisture Traps
Reference: Timber Service Life Design Guide, FWPA 2007

Working with EWPs

Care must be taken when working with preservative treated EWPs to ensure the effectiveness of the treatment is not compromised. Often the preservative envelope of protection around EWPs will be broken (damaged) by on-site cutting or machining operations. Where this occurs it is good building practice to apply supplementary on-site protection in the form of a flood brush coating of water repellent preservative, for example a thick coating of copper napthenate (CN) emulsion, should be applied to the cut surfaces. For EWPs treated to H1 or H2 a spray or paint-on insecticide may be used. Creosote oil or PEC should be applied by flood brushing where this treatment has been applied to the EWPs. Supplementary treatment of cut surfaces is required (Normative) by the AS/NZS 1604 series of standards wherever an envelope treatment penetration pattern "E" has been employed in the product (see section Regulatory and Practical Limitations). It should be noted that supplementary on-site application of preservatives is not a normative requirement where full cross-section treatment has been applied.

Many particleboard and veneer-based products are now treated through the full cross-section via glue line additives for H1 and H2 and veneer treatment prior to gluing for H3 and H4 treated products. This includes ACQ treated plywood products. In these cases, a brush-on supplementary treatment is not required.

It is also considered good building practice to apply supplementary on-site protection in the form of a flood-brush coating of a water repellent preservative such as a thick coating of copper napthenate (CN) emulsion applied to all high risk areas of EWPs in a structure. This may include areas around joints, horizontal contact surfaces or in ground. Such action can considerably enhance the service life of the EWPs by preventing, or at least delaying the on-set of decay or insect attack at these "weak" points.

Finishing

Finishing of preservative treated EWPs is essential to prevent the appearance of weathered wood surface mechanical breakdown (cracking) and to provide some protection against moisture related shrinkage and swelling. Finishes provide a protective vapour barrier to the surface, rather than a total moisture seal. The broad range of commercial finishes available for EWPs includes paints, clear finishes, water repellent and stains. Selection of the appropriate finish depends upon the desired appearance, cost and intended maintenance regime. Table 12 provides an indication of suitable exterior timber finishes, their effectiveness and relative cost.

Although paint finishes have an initial benefit in protecting EWPs against weathering, and therefore delaying the on-set of decay, the paint finish must be well maintained to ensure an on-going benefit. Cracked or deteriorated finishes can allow wetting of the wood substrate and in turn prevent the wood redrying. This can result in accelerated decay where the wood substrate is of low natural durability or not adequately treated with robust preservatives. A good paint finish will enhance the durability performance of preservative treated sapwood and naturally durable heartwood.

Durable hardwood Glulam bridge finished with exterior paint (Airley Beach, Qld).
(Courtesy Timber Queensland)

Stained exterior plywood cladding.
(Courtesy CHH Wood Products Australia)

The following key factors provide guidance on the selection of suitable finishes:

- Pale colours reflect more heat and light so generally perform better than dark colours due to their greater resistance to weathering.
- Oil-based paint systems generally provide a more effective moisture barrier protection than acrylic systems. Note the EWPAA strongly discourages the use of oil-based finish systems on exposed plywood or LVL (refer to “Specific recommendations” below).
- Quality primer and undercoats are recommended to provide a good surface seal and “key” for adhesion of top coats.
- Paint finishes have a longer effective life-span requiring less frequent maintenance than stains and water repellents.
- Rougher, sawn surfaces provide a better “key” for adhesion of stains and water repellents than do smooth, dressed surfaces.

Some EWPs may be supplied pre-primed or otherwise seal-coated for temporary protection during handling and installation. In these cases the product should be finished in accordance with the manufacturers’ instructions.

Exterior membranes and surface coverings (such as exterior carpets and waterproof deck systems such as tiled fibre-cement) must be properly installed and maintained in accordance with the manufacturers instructions to ensure they do not expose inadequately treated EWPs to water leaking through “waterproof” membranes.

Table 12: Exterior wood finishes: Types, Treatments and Maintenance

Finish	Initial Treatment	Appearance of Wood	Cost of Initial Treatment	Maintenance Procedure	Maintenance Period of Surface Finish (vertical applications)	Mainten-ance Cost
Paint	Prime and two top coats	Grain and natural colour obscured	Medium to High	Clean and apply top coat or remove and repeat initial treatment if desired	7 – 10 years[b)]	Medium
Clear (film forming)	Four coats (minimum)	Grain and natural colour unchanged if adequately maintained	High	Clean and stain bleached areas and apply two more coats	2 years or when break-down begins	High
Water Repellent [c)]	One or two coats of clear material, or preferably dip applied	Grain and natural colour; visibly becoming darker and rougher textured	Low	Clean and apply sufficient material	1 – 3 years or when preferred	Low to medium
Stains	One or two brush coats	Grain visible; coloured as desired	Medium	Clean and apply sufficient material	3 – 6 years or when preferred	Medium
Organic Solvents Preserva-tives [d)]	Pressure, steeping, dipping, brushing	Grain visible; coloured as desired	Low to Medium	Brush down and reapply	2 – 3 years or when preferred	Medium
Waterborne Preserva-tives	Pressure	Grain visible; greenish or brownish; fading with age	Medium	Brush down to remove surface dirt	None unless stained, painted or varnished	Low to medium for stained or painted

Notes:

a) *This table is a compilation of data from the observations of many researchers*
b) *Using top quality acrylic latex paints*
c) *With or without added preservatives. Addition of preservative helps control mildew and mould growth.*
d) *Tri-n-butyltin oxide, azoles, copper naphthenate etc.*
e) *The maintenance period may be expected to be significantly less (generally accepted about half) than the period for vertical applications given in the table.*
f) *Reference: Timber Service Life Design Guide, FWPA 2007*

Overlays

Some panel products may be available with overlays to provide specific functionality to the EWP such as abrasion resistance, weather protection, insulation, security, and the like. For example plywood may be available with overlays:

- Medium density phenolic impregnated paper overlays to improve weather resistance and provide high quality finishes. High density overlays are used for formply concrete formwork and vehicle bodies.
- Fibreglass to provide water proofing and liquid containment.
- Metal sheet overlays.
- Fibre-cement sheet overlays.
- Sound transmission layers.

Special considerations

Some complications may arise in relation to painting or finishing EWPs. Resin bleed can occasionally be a problem with softwood components. It occurs naturally in some softwoods and appears as a sticky clear or white exudation from knots or other imperfections where resin builds up. Where it occurs, the resin should be removed from the surface, the area allowed to weather or "breathe" for at least a few days, a suitable knot sealant applied, followed by the selected surface finish system.

Care is required when painting LOSP (light organic solvent preservative) treated EWPs. The presence of solvent and water repellent residues may be detrimental to the performance of some subsequent surface finishes. Volatile solvents applied during the treatment process must be allowed to evaporate (dry) from the surface of the wood prior to painting. It is recommended that LOSP treated products are left for a minimum of 7 days after installation before application of a suitable surface finish. Finishing with either semi-transparent, penetrating stains or painting is recommended. A good quality oil-based primer (acrylic primer recommended for plywood and LVL) is required before the application of oil-based or acrylic paint systems.

Durable hardwood Glulam column finished with semi-transparent exterior timber stain.
(Courtesy Stephen Bolden)

It is important to note AS/NZS1604 specifies that timber and EWPs treated and marked "H3 A" are intended to be used in predominantly vertical applications, such as exterior cladding and posts, and must have supplementary protection in the form of an appropriate, well maintained paint system.

Note that plywood with A or B grade face veneer quality, which has also been sanded or textured provides the most suitable substrate to receive a high quality surface finish. C or D grade face veneers contain knots or knot holes and other imperfections which will not allow high quality surface finishes.

More detailed guidance on the suitability of different surface finishes in conjunction with a range of treatment types is available from treatment suppliers.

Specific recommendations

The following specific recommendations relate to the application of finishes to EWPs:

- The Engineered Wood Products Association of Australasia (EWPAA) recommends the use of 100 percent acrylic latex paint systems on weather exposed plywood based on field trial results (www.paa.asn.au). A satisfactory system comprises 1 coat of 100 percent acrylic latex stain blocking primer and 2 top coats of acrylic latex exterior paint.
- Plywood may be supplied with medium density phenolic impregnated paper overlays. Rigid paint systems including oil-based and alkyd enamel paints are suitable for use on overlays, but not on raw plywood surfaces in weather exposed environments.
- Edge sealing of panels such as plywood in weather exposed situations is considered good practice and recommended to minimise moisture uptake through exposed wood end grain.
- The durability performance of LVL cross-arms on power poles has been demonstrated to significantly improve by installation of a quality, light coloured paint finish to the top horizontal surface of the cross-arm.

Maintenance

Most buildings and structures will require regular maintenance to ensure their continued performance of structural and appearance functions. Structures incorporating EWPs should be regularly inspected and maintained generally following guidance provided by Table 13.

Table 13: Selection and Scheduling of Maintenance

Item	Suggested Maintenance and Inspection Periods	Remarks
Finishes • **External** • **Internal**	 Refer to Table 18 As required but approximately every 10 – 15 years	
Building Envelope – Cladding, roofing, weatherproofing	Varies depending upon initial quality of materials, however, ten year inspections would be warranted for most products	These can be designed for specific lives from 5 years to 100 + years
Termite Protection • **Mechanical Barriers** • **Chemical Barriers**	 Approximately 10 years. Replenish at intervals in accordance with manufacturers registration labels.	 Refer to AS 3660.1
Ventilation – Subfloor, wall and roof	Ensure vents remain unblocked. Clean where necessary – 10 years	Vents are often covered over during new work. This must be avoided or new vents installed
Vapour Barriers	Check integrity or vapour barriers in roofs, under floors, approximately at 15 year intervals	
Metal Fasteners • **Corrosion**	 Varies depending upon initial quality of materials and presence of hazards	 If corrosion present, repair or replace immediately to prevent further ingress of Moisture/dirt
• **Integrity**	If unseasoned timber is used, re-tighten bolts, screws etc. after 6 months and 12 months. If nails become loose, re-punch or re-nail where necessary.	Use of hot-dipped galvanised fasteners overcomes many fixing problems. Use stainless steel in marine environments.
Plumbing	Repair or replace leaking or defective material immediately and re-establish finish (inspection cycles determined by above)	Presence of moisture increases possibility of decay and termite attack.
Decay	If noticed, repair or replace defective material immediately and re-establish finish (inspection cycles determined by above).	
Supplementary Preservatives, end grain sealants and end grain plating	Require inspection and/or maintenance about 3 – 5 year intervals, depending upon type and application.	Usually used in heavy engineering applications, such as wharves, bridges and posts in ground
Cleaning	Clean surfaces as required. Use of blowers rather hosing down is far better, particularly for decks	Build up of dirt etc. on timber surfaces will increase potential for decay via moisture traps

Notes: *Reference: Timber Service Life Design Guide, FWPA 2007*

The effect of maintenance on the service life of a structure is shown in Figure 14. Failure to maintain buildings against the effects of the variety of environmental exposure hazards can significantly reduce the service life.

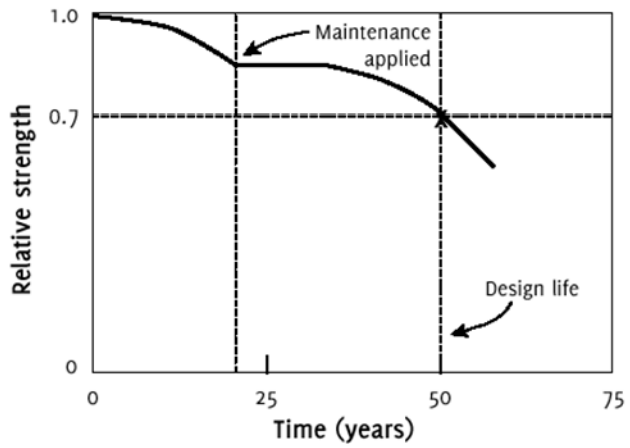


Figure 14: Illustration of the effect of a maintenance procedure
Reference: Timber Service Life Design Guide, FWPA 2007

Safety and Environmental Protection

Treated EWPs are generally safe to use, but all users should be cognisant of relevant handling guides, consumer information sheets and material safety data sheets (MSDS's) with respect to the use, application and disposal of EWPs. Precautions should be observed by all users handling, machining, installing, or disposing of EWPs.

Care should be taken to dispose of treated timber waste in accordance with manufacturers' instructions. Treated EWP waste should not be mixed with general green waste for composting nor should it be burnt in uncontrolled situations.

Pergola constructed from pine Glulam, H3 treated, primed and painted for full exposure to weather.
(Courtesy Hyne)

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AS 1604.1:2005	Part 1: *Sawn and round timber*
AS/NZS 1604.2:2004	Part 2: *Reconstituted wood-based products*
AS/NZS 1604.3:2004	Part 3: *Plywood*
AS/NZS 1604.4:2004	Part 4: *Laminated veneer lumber (LVL)*
AS/NZS 1604.5:2005	Part 5: *Glued laminated timber products*

Standards Australia, AS 1684 *Residential timber-framed construction*. SAI Global, Sydney.

AS 1684.1:1999	Part 1: *Design criteria*
AS 1684.2:2006	Part 2: *Non-cyclonic areas*
AS 1684.3:2006	Part 3: *Cyclonic areas*
AS 1684.4:2006	Part 4: *Simplified non-cyclonic areas*

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Some useful internet sites providing further information about preservative treatment and use of EWPs:

http://www.timber.org.au – Forest and Wood Products Australia
http://www.ewp.asn.au/ - Engineered Wood Products Association of Australasia
http://www.gltaa.com/ - Glued Laminated Timber Association of Australia
http://www.woodpanels.org.au – Australian Wood Panels Association
http://www.tpaa.com.au/ - Timber Preservers Association of Australia
http://www.osmose.com.au/ - Osmose Australia Pty Ltd.
http://www.archchemicals.com/Fed/WOODAU - Arch Wood Protection (Aust) Pty Ltd
http://www.timtech.info/ - TimTech Chemicals Ltd.

APPENDIX A: Detailed preservative specifications for the treatment of EWPs

This Appendix provides detailed specifications for the treatment of EWPs in Tables A1 to A6 listing the current preservative types, designations and retentions (%m/m) for each of the six hazard Classes recognized in the AS/NZS 1604 series

H1 treatment

All Lyctus-susceptible hardwood sapwood must be treated. In the case of OSB and particleboard the fibre particles should be <3 mm thick. For plywood and LVL, all susceptible veneers should be treated, and for Glulam the susceptible sapwood should be treated.

Note that the requirement to treat Lyctus-susceptible hardwood sapwood applies to all other hazard classes, in addition to their other requirements. Softwoods are non-lyctus susceptible.

Table A1: Preservative retentions (% m/m) for EWP H1 treatment

	OSB, particleboard	**Plywood**	**LVL**	**Glulam**
Treatment Designation	**P**	**V**	**V**	**T**
Boron[1]	0.047	0.047	0.047	0.047
CCA (Cu + Cr + As)	0.100	0.035[2]	0.035[2]	0.035[2]
ACQ	0.17	0.17	0.17	0.17
LOSPs:				
Bifenthrin	0.0012	0.0012	0.0012	0.0012
Permethrin	0.0060	0.0060	0.0060	0.0060
Cypermethrin	0.0060	0.0060	0.0060	0.0060
Deltamethrin	0.00060	0.00060	0.0006	0.00060
Bifenthrin	0.0012	0.0012	0.0012	0.0012
Permethrin	0.0060	0.0060	0.0060	0.0060
Fluorine[1]	0.140	0.140	0.140	0.140

[1] elemental
[2] elemental arsenic

H2 treatment

There are four designated treatment methods for the protection of OSB and particleboard: all the fibre particles to be treated before fabrication (designated P); the manufactured whole panel treated to deliver a protective envelope of 80% of the cross section (designated E); the adhesive to be dosed with an approved insecticide (designated G); or, the glueline dosed as well as the face layers treated (designated G/F).

All veneers in a plywood sheet must show evidence of preservative penetration (designated V), or an envelope treatment of the plywood sheet is permitted requiring the face and back veneers to be fully penetrated by the approved preservative as well as a defined penetration depth of all the other veneers within a prescribed distance from the edges and ends of the plywood sheets (designated E); these distances are less tolerant if the plywood is to be used north of the Tropic of Capricorn where the termite hazard is most severe. Glueline treatments are also permitted as well as a combination of glueline and face veneers treatment (designated G/F). There are limitations on the thickness of the veneers for glueline-only treatments (designated G), with thinner veneers (not thicker than 2.5 mm) prescribed for use north of the Tropic of Capricorn. The preservative specifications for LVL are similar to plywood, except that in the case of an envelope treatment there is no face veneer requirement – the preservative should penetrate all sapwood and non-termite-resistant heartwood in all the veneers within specified zones of the surfaces, edges, and ends.

Preservative penetration of all sapwood Glulam laminates before fabrication is required as well as 5 mm from the face or edge of non-termite resistant heartwood laminates, when the lesser cross-section dimension is <35 mm, or 8 mm if it is >35 mm. Unpenetrated heartwood is permitted with some restrictions on its distribution within individual laminates.

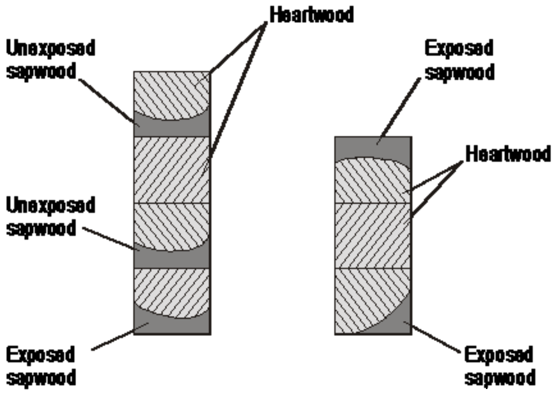

Figure A2: Exposed and unexposed sapwood in Glulam.

Where the Glulam is treated after fabrication the preservative must penetrate all exposed sapwood (i.e. sapwood on adjacent exposed surfaces and not enclosed by heartwood) and, if termite resistant heartwood is present, all unexposed sapwood within 5 mm of the faces or edges (8 mm if the cross-section is >35 mm), or it can remain untreated if it comprises <20% of the cross-section and does not extend more than half way through the Glulam, and does not exceed half the dimension of the faces or edges on which it occurs.
If the timber species used is non-termite resistant, the preservative must penetrate all heartwood and all unexposed sapwood within 5 mm of faces and edges (8 mm if the cross-section is >35 mm). Unpenetrated heartwood and unpenetrated unexposed sapwood is allowed if, together, they comprise <20% of the cross-section and do not extend more than half way through the Glulam, and do not exceed half the dimension of the faces or edges on which they occur.

Table A2: Preservative retentions (% m/m) for EWP H2 treatment

	OSB and particleboard			Plywood and LVL			Glulam
Treatment designation	**P, E**	**G**	**G/F**	**V, E**	**G**	**G/F**	**T, E**
As[1]	-	0.130	-	-	0.130[2, 5]	-	-
Boron[1]	-	-	-	0.0470	-	-	0.047
CCA (Cu+Cr+As)	0.320	-	-	0.320	-	-	0.320
ACQ	0.350	-	-	0.350	-	-	0.350
LOSPs:							
Bifenthrin	0.0047	0.0047	0.0047	0.0042	0.0083[4]	0.0042[4]	0.0047
				0.0008[3]	0.0021[3]	0.0021[3, 5]	0.0200
Permethrin	0.0200	0.0200	0.0200	0.0200	-	-	0.0300
Cypermethrin	0.0300	-	-	0.0300	-	-	0.0020
Deltamethrin	0.0020	0.0100[3]	0.0100[3]	0.0020	0.0100	0.0067[3, 5]	-
		0.0020[3, 6]	0.0020[3]				
Bifenthrin	-	-	-	0.0042 0.0008[3]	0.0083[4] 0.0021[3, 5] 0.0027[3, 7] 0.0028[3, 8]	0.0042[4] 0.0021[3]	0.0047
Permethrin	-	-	-	0.0200	-	-	0.0200
Imidacloprid	0.00093	0.00093[3]	-	-	0.0006[3, 5] 0.0027[3, 7]	0.0006[3, 5]	-

[1] elemental [2] in the form of As_2O_3 in the adhesive [3] southern regions only [4] veneers <2.5 mm thick
[5] veneers <3.2 mm thick [6] in the face layer only [7] softwood veneers <4.3 mm [8] hardwood veneers <2.5 mm thick

H3 treatment

Particle treatment and finished sheet treatments are required for OSB and particleboard. Particleboard and OSB treated to H3 are not currently available in Australia.

In the cases of plywood and LVL, an envelope treatment or a veneer treatment is required; no glueline treatments only are approved. For plywood sheets, an envelope of preservative must penetrate face and back veneers and all sapwood and non-durable (above-ground) classes 2, 3, and 4 heartwood within 150 mm of the ends and edges of the sheet, or there must be evidence of penetration in all sapwood and non-durable heartwood veneers before they are put together in the sheet. For LVL all sapwood within 10 mm from the surfaces, 20 mm from the edges, and 150 mm from the ends should be treated as well as non-durable (above-ground) classes 2, 3, and 4 heartwood, except if it is not within 10 mm of any surface and it does not exceed more than 35% of the cross-section. Alternatively, there must be evidence of penetration in all sapwood and non-durable (above-ground) heartwood veneers before they are glued together.

H3 preservative requirements for Glulam are identical to the H2 requirements, except that durability references are to above-ground performance, not just termite resistance. Also the approved preservatives are different.

Table A3: Preservative retentions (% m/m) for EWP H3 treatment

		OSB and particleboard	Plywood and LVL	Glulam
Treatment designation		**P, E**	**V, E**	**T, E**
CCA (Cu + Cr + As)		0.380	0.380	0.380
ACQ	softwood	0.350	0.350	0.350
	hardwood	0.390	0.390	0.390
Cu Azole		0.229	0.229	0.229
LOSPs[1]:				
	Bifenthrin	0.0047	-	0.0047
	Permethrin	0.020	0.020	0.020
	Cypermethrin	0.030	0.030	0.030
	Deltamethrin	0.002	0.0020	0.0020
	Tin compounds	0.080	0.080	0.080
		0.160[2]	0.160[2]	0.160[2]
	Cu naphthenate	0.100	0.100	0.100
	Azoles[3]	0.060	0.060	-
BAC[3]		2.00	2.00	2.00
Creosote		8.00	8.00	8.00

[1] formulated with an insecticide/fungicide
[2] for horizontal structures
[3] formulated with an insecticide

H4 treatment

OSB and particleboard are not specified in AS/NZS 1604 SERIES for H4 exposure conditions.

The preservative penetration requirements for plywood and LVL are identical to the H3 requirements, except natural durability is specified in terms of in-ground contact for classes 3 and 4 heartwood, and the preservatives and their retentions are different.

While the H4 treatment requirements for Glulam are, in principle, the same as those for H3, more rigorous penetration is required and the preservative and their retentions are different. There is no heartwood penetration requirement if the prefabricated laminates are from in-ground durability class 1 and 2 timbers, but all sapwood must be treated. For in-ground durability class 3 and 4 heartwood the preservative must penetrate all sapwood and a minimum of 10 mm from the face or edge of each prefabricated laminate. For treatment of in-ground durability class 1 and 2 timber laminates after fabrication, the preservative must penetrate all exposed sapwood and all unexposed sapwood within 10 mm of the face or edge of the fabricated Glulam. For treatment of in-ground durability class 3 and 4 timber laminates after fabrication, the preservative must penetrate all heartwood and all unexposed sapwood within 10 mm of the face or edge of the fabricated Glulam.

Allowances for unpenetrated heartwood in prefabricated laminates and unpenetrated unexposed sapwood in the fabricated Glulam are the same in both H3 and H4 treatments.

Table A4: Preservative retentions (% m/m) for EWP H4 treatment

		Plywood, LVL and Glulam
Treatment designation		**V, E, T**
CCA (Cu + Cr + As)	softwood	0.630
	hardwood	0.700
ACQ	softwood	0.890
	hardwood	0.980
Cu Azole	softwood	0.416
	hardwood	0.499
Creosote/PEC	softwood	20.0
	hardwood	10.0

H5 treatment

OSB, particleboard and Glulam are not specified in AS/NZS 1604 SERIES for H5 exposure conditions.

An envelope or veneers treatment is permitted for plywood. There is no heartwood penetration requirement if the species of timber used is of in-ground durability class 1 or 2. All the sapwood and face and back veneers of in-ground natural durability class 3 and 4 timbers must be penetrated as well as sapwood and heartwood within 150 mm of the sheet ends and edges. Untreated heartwood of in-ground durability class 3 and 4 timbers in veneers is permitted, provided that it is not within 10 mm of the end or edge of the plywood sheet and it does not exceed 35% of the cross-section at any point within 150 mm of the sheet ends or edges. LVL is treated similarly to plywood and preservative must penetrate sapwood and heartwood of in-ground natural durability class 3 and 4 timbers within 10 mm from the surfaces of face and back veneers, 20 mm of the edges, and 150 mm from the ends.

The treatment requirement of manufactured plywood sheets and LVL is that all sapwood and heartwood of in-ground natural durability class 3 and 4 timbers shall show evidence of penetration in the veneers.

Table A5: Preservative retentions (% m/m) for EWP H5 treatment

		Plywood and LVL
Treatment designation		**V, E, T**
CCA (Cu + Cr + As)	softwood	1.00
	hardwood	1.20
ACQ	softwood	1.41
	hardwood	1.69
Creosote/PEC	softwood	24.5
	hardwood	13.0

H6 treatment

Plywood is the only EWP currently specified in AS/NZS 1604 SERIES for H6 marine exposure. For these products there must be complete penetration of face and back veneers as well as evidence of treatment in the full cross-section of the sheet. Only two preservatives are allowed and they are used either in combination as a double-treatment or singly, depending on the region of exposure.

Table A6: Preservative retentions (% m/m) for EWP H6 treatment

Treatment designation		Plywood	
		V	
		Southern waters[1]	Northern waters[2]
CCA (Cu + Cr + As)	softwood	2.0	2.0
	hardwood	1.2	1.2
Creosote/PEC	softwood	40.0	40.0
	hardwood	22.3	15.2

[1] as stand-alone treatments
[2] as double treatments of CCA followed by creosote/PEC