Understanding the characteristics of Plywood and LVL, and how these products are used.
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The Benefits of Using EWPAA-JAS-ANZ Product Certified Plywood and LVL

- Product certification to relevant Australian and New Zealand Standards.
- Product acceptance by building and lending authorities.
- Deemed to satisfy product certification requirements of the Building Code of Australia (BCA).
- Availability of technical data relating to product application in residential and commercial construction.
- Defined and predictable physical and mechanical properties.
- Availability of professional advice from qualified EWPAA technical staff.
- Compliance with SAA Codes of Practice, AS 1684 Residential Timber-Framed Construction Code, AS 1720 Timber Structures Code, and AS 3610 Formwork for Concrete Code.
- EWPAA-JAS-ANZ branded product is recognised by the Federal and State governments as meeting their purchasing requirements.
- Readily available due to local production
- Reliability of design data

Plywood and LVL Standards

EWPAA members manufacture standardised plywood and LVL products to the following Australian and New Zealand Standards under the EWPAA products certification scheme:

- AS/NZS 2269: 2008 Plywood – Structural
- AS/NZS 2270: 2006 Plywood and Blockboard for Interior Use
- AS/NZS 2271: 2004 Plywood and Blockboard for Exterior Use
- AS/NZS 2272: 2006 Plywood – Marine
- AS/NZS 4357: 2005 Structural Laminated Veneer Lumber
- AS 6669: 2007 Plywood Formwork

The following standards are used in relation to sampling and testing:

- AS/NZS 2097: 2006 Methods of Sampling Veneer and Plywood
- AS/NZS 2098: 2006 Parts 1 to 8 Methods of test for Veneer and Plywood
- AS/NZS 2098: 2006 Part 11 Determination of Formaldehyde Emissions for Plywood
- AS 2754.1: 1985 Adhesives for Plywood Manufacture

The following standards are also applicable to plywood and Laminated Veneer Lumber (LVL):

- AS 1684: 2006 Residential Timber-Framed Construction Code details the application of structural plywood in residential flooring and structural wall bracing applications. The Standard also covers the application of structural plywood in residential roofing application.

- AS 1720.1: 1997 Timber Structures Code provides details for the use of plywood and LVL in engineered timber structures. The code contains the design methodology for both plywood and LVL as well as information on the design capacity of various fastener types. Structural plywood is the only wood based panel product specified in the code Characteristic strengths and moduli of elasticity and rigidity are given for
eight stress grades of structural plywood. This code is important for all designers, architects and engineers involved with timber structures.

AS 3610: 1995 Formwork for Concrete provides details of the application of plywood in concrete formwork.

Plywood Dimensions & Specification

Plywood Panels – Standard Dimensions
Plywood is available in several lengths and widths and a wide range of thickness, however the standard plywood panel dimensions are:

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>2700, 2400 and 1800mm</td>
<td>1200mm</td>
</tr>
</tbody>
</table>

Panel lengths of 2250 and 2100mm and a panel width of 900mm are also available from some manufacturers.

Some panel lengths are governed by the manufacturers proposed end use for the plywood. For example, the 2250mm panel is intended for flooring and the length is to suit the standard floor joist spacing of 450mm. Flooring plywood is usually supplied with plastic tongue and grooved (T&G) edges. Plywood bracing is available in panels 2440mm and 2745mm in length to give top and bottom plate coverage.

Non standard panel sizes are also available on request from a number of manufacturers. Large panel sizes are available in scarf jointed form.

A range of standard plywood panel thickness are available including 3, 4, 5, 6, 7, 9, 12, 15, 16, 17, 19, 20, 21, 25 and 28 mm. Thickness available will vary between different manufacturers and the intended market for the plywood panel. It is best to check both panel thickness and size locally available before specifying the plywood.

Specifying Plywood
When specifying plywood the following information should be supplied: the number of panels x thickness (mm) x width (mm) x thickness (mm), the plywood type and standard, the stress grade and ID code (for structural plywood), the face and back grades and the glue bond type, EWPAA products certification stamp and preservative treatment level if required. For example a typical specification for structural plywood flooring with tongue and grooved edges might be:

20 sheets of 2400 x 1200 x 17 mm, T&G, Structural plywood to AS/NZS 2269 F11 (17-24-7)
CD – A bond
EWPAA Product Certified

Gluelines
Four types of glue bonds are defined and specified in AS 2754.1 Adhesives for plywood Manufacture. The bond types are A, B, C and D, in decreasing order of durability under conditions of full weather exposed.

Type A bond is produced from a phenol formaldehyde (PF) resin, which sets permanently under controlled heat and pressure. It forms a permanent bond that will not deteriorate under wet conditions, heat or cold. It is readily recognisable by its black colour.

Type A bond is specified in AS/NZS 2272 for marine plywood, AS/NZS 4357 for structural LVL and AS/NZS 2271 for exterior plywood used under conditions of long term full exposure or under wet or damp conditions.
The EWPAA Tested exterior, structural, structural LVL, formwork plywood and marine stamps are applied to Type A bonded plywoods.

**Type B bond** is produced from melamine fortified urea formaldehyde resin (MUF) which sets under controlled heat and pressure. Type B bond is included in the exterior plywood standard and is suitable for applications involving concrete formwork plywood is stamped with the EWPAA Approved B bond stamp.

**Type C and D bonds** are both interior bonds and should not be recommended for any purpose where exterior use or use under wet or damp conditions are involved, or long terms load bearing conditions are involved. Even interior use C and D type bond should not be recommended for structural applications. *(Type A bonded plywood should be used for areas of doubtful moisture conditions, such as areas around sinks, vanity units and laundry tubs).*

Type C and D bonds are produced from urea formaldehyde resin, (UF) which sets under controlled heat and pressure. The glueline is light coloured. Types C and D bonds are specified AS/NZS 2270 for interior plywood and are suitable for interior non-structural application. Types C and D bonded plywoods are branded with the EWPAA Approved interior stamp.

The formaldehyde adhesives used in plywood manufacture are thermosetting and will not re-plasticise under reheating as do thermoplastic adhesives such as elastomeric wall board adhesives and PVA.

Formaldehyde emission from most plywood products is at or below the stringent E1 requirement of 0.1 ppm accepted internationally. Phenolic Type A bonds have particularly low formaldehyde emission, of between 0.00 to 0.03 ppm, corresponding to E0 (which is 0.05ppm).

### Veneer Quality

There are 5 veneer qualities specified for plywood in the Australian and New Zealand Standards. The veneer qualities specified are A, S, B, C and D.

The plywood face veneer quality is specified as the face veneer quality first followed by the back face veneer quality. Typical examples are: AA for marine plywood, AD for a wall cladding where only the front face of the plywood is visible, CD for structural plywood flooring and DD for structural bracing.

**Veneer Quality A** is a high quality appearance grade veneer suitable for clear finishing. This appearance grade quality should be specified for the face veneer in plywood where surface decorative appearance is a primary consideration.

**Veneer Quality S** is an appearance grade veneer which permits natural characteristics that are acceptable is to be based on a written specification, acceptable to both the manufacturer and the purchaser.
Veneer Quality B is an appearance grade suitable for high quality paint finishing. This face veneer quality should be specifically used for applications requiring a high quality paint finish and is not generally suitable for clear finishing.

Veneer Quality C is defined as a non-appearance grade with a solid surface. All opens defects such as knot holes or splits are filled. Plywood with a quality C face is designed specifically for applications requiring a solid non-decorative surface such as a plywood flooring which is to be overlaid with a decorative flooring surface.

Veneer Quality D is defined as a non appearance grade with permitted open imperfections. Limited numbers of knots and knot holes up to 75 mm wide are permitted in Veneer Quality D. Plywood manufactured with face veneer quality D is the lowest appearance grade of plywood. It is designed specifically for structural applications where decorative appearance is not a requirement, for example structural plywood bracing.

Structural Plywood

Structural Plywood manufactured to AS/NZS 2269 Plywood-Structural is suitable for use in all permanent structural applications. A permanent Type A phenolic resin is used to bond the individual timber veneer. The Type A bond is distinctly dark in colour and is durable and permanent under conditions of full weather exposure, long term stress, and combinations of exposure and stress.

Structural plywood is manufactured from a range of softwood and hardwood timber species. These timber species may not be durable when used in weather exposed situations. In exposed applications, structural plywood must be preserved treated to ensure it last its full service life and surface finished to minimise surface checking.

EWPAA branded structural plywood is manufactured under a rigorous product quality control and product certification system ensuring a quality controlled engineered panel of known and consistent physical and mechanical properties. For assured performance structural plywood should be branded with the “EWPAA Tested” stamp.

The engineering properties of structural plywood are tabulated in both AS/NZS 2269 and AS 1720.1. Structural plywood engineering properties are given for eight standard stress grades of F7,F8,F11,F14,F17,F22,F27 and F34.

ID Code: the veneer arrangement within structural plywood is required to establish the section properties of a particular plywood assembly. The information can be established from the plywood identification code. The ID code gives the following data: the normal plywood thickness, the face veneer thickness multiplied by 10, and the number of piles in the assembly.

For example, the ID code 17-24-7 describes a 17 mm thick plywood with face veneer thickness of 2.4 mm and seven veneer layers. Standard constructions for structural plywood are detailed in AS/NZS 2269 (and various other EWPAA literature).
Five face veneer qualities A, S, B, C and D are provided. (Refer to the section on veneer quality for a description of each veneer grade). Structural plywood can be economically specified with appropriate face and back veneer qualities to suit the specified application. For example typical specifications are: for plywood bracing where appearance is not important and the prime consideration is structural performance. DD grade; for tongue and grooved structural flooring requiring a solid face, CD grade; and for preservation treated external cladding also acting as structural bracing AD or BD grade.

Concrete Formwork Plywood

Plywood used as concrete formwork must comply with AS 6669 Plywood-Formwork, which includes the structural requirements of AS/NZS 2269; the bond type however can be a type A, B or C bond in accordance with AS 2754.1. All concrete formwork plywood must be branded with a stress grade to AS/NZS 2269 and a bond type.

Plywood possesses properties which are excellent for concrete formwork it is estimated that the majority of all concrete formwork facing is plywood. Plywood characteristics which are utilised to advantage in formwork are high strength and high stiffness to weight ratio, dimensional stability, ease of working and impact resistance.

The EWPAA publication plywood in concrete formwork which is available from the EWPAA website, contains engineering data which is essential for the design of concrete formwork. The manual contains information on plywood properties and formwork design and installation procedures which assist in the optimised, economical design of EWPAA plywood formwork systems.

Formwork overlay types and performances vary and recommendation regarding suitable overlay types and quality for various concrete finishes are contained in the manual Plywood in Concrete Formwork.

Not all concrete formwork plywood requires an overlay. Non overlaid or raw plywood can be used in application where off form finish is not critical. However, all plywood used for concrete formwork needs coating with release agents (form oil), regardless of whether or not it has been surfaced with an overlay. Release agent is still required on raw plywood formwork.

All concrete formwork plywood should be edge sealed. All re-cut edges and holes should be re-sealed.

The life of the formwork plywood depends on care and maintenance at the site. Re-used depends almost entirely on site factors, and cannot therefore be predicated accurately.

EWPAA branded plywood is manufactured under a rigorous product quality control and product certification system. This ensures a quality controlled, engineered panel of known and consistent physical and occupational health and safety reasons, only EWPAA certified plywood should be used for formply.
Marine Plywood

Marine plywood manufactured to AS/NZS 2272 Plywood – Marine is a purpose built structural plywood, intended for use in hulls of boats and other marine application and also in aircraft construction. It has a permanent Type A Phenolic bond and is manufactured from selected species based on density, bending strength, impact resistance and surface finishing characteristics.

None of the marine species are naturally durable and preservative treatment of marine plywood used in some marine environments.

Preservative treatment of marine plywood can be either carried out in a treatment plant prior to sale or in situ. In either situation the protection is an envelope treatment and all cut edges should be re treated in situ.

As most preservation affect resorcinol bonding, advice should be sought from adhesive and preservative manufactured if gluing of preservative treated plywood is intended.

Marine plywood to AS/NZS 2272 is made from selected species and therefore has known and consistent structural properties. The assigned stress grade of plywood manufactured to AS/NZS 2272 is F14.

Marine plywood to AS/NZS 2272 has two A grade faces and a Type A bond. In the Australian / New Zealand Standards grading system it therefore has a grading of AA-A bond

Note that marine plywood manufactured to BS 1088, as imported into Australia, does not have predictable structural performance and must not be substituted for AS/NZS 2272 marine plywood. For assured performance marine plywood should be branded with the ‘EWPAA Tested’ marine plywood stamp.

Laminated Veneer Lumber - LVL

Structural Laminated Veneer Lumber (LVL) manufactured to AS/NZS 4357 Structural Laminated Veneer Lumber is an assembly of veneer laminated with a type A Phenolic resin.

The grain direction of the outer veneers and of most or all of the inner veneer is in the longitudinal direction. LVL is suitable for use in all permanent structural applications and it has a wide variety of uses including beams and columns, truss chords, I-beam flanges, scaffold planks, concrete formwork supports and supports for structural decking.

Although the Type A bond is durable and permanent under conditions of full weather exposure and stress, the timber species may not be durable when used in weather exposed situations. In exposed applications, structural LVL must be preservative treated to ensure it last its full service life and surface finished to minimise surface checking. Note that some chemical treatments may adversely affect structural properties and advice should be sought from the manufactured prior to any treatment.

The design properties of structural LVL, as well as product dimensions, are published by the individual manufactured.
LVL dimensions vary between manufacturers, however manufactured billets are nominally 1200 mm wide and in standard thickness of 35 or 36, 39, 45 and 63 mm. Other thickness are available from some manufactured.

The 1200 mm wide billet is ripped into standard beam depths and includes beam depths of 1200 mm deep. The veneer grades for LVL are controlled by the manufacturing specification of each individual LVL manufacturer.

EWPAA branded structural LVL is manufactured under a rigorous product quality control and product certification scheme. This ensures an engineered product of known and consistent physical and mechanical properties. For assured performance, structural LVL should be branded with the “EWPAA Tested” structural laminated veneer lumber stamp.
Exterior and Interior Plywood

**Exterior Plywood** manufactured to AS/NZS 2271 is intended for use in non structural, exterior application where a high quality aesthetic finish is required. Typical applications include exterior door skins, hoarding, signs and non structural claddings.

Exterior plywoods to AS/NZS 2271 may posses either a permanent Type A bond or a less durable Type B bond melamine urea formaldehyde bond. Type A bonded exterior plywood must be specified for applications involving long term full exposure. Type B bonded plywood can be specified for semi-exposed applications or when the maximum exposure time totals less than two years.

All permanently exposed Type A bonded exterior plywood should be treated against fungal attack and the surface should be finished with paint or water repellents to minimise mechanical surface checking.

**Interior Plywoods** manufactured to AS/NZS 2270 is intended for use in non structural interior application where a high quality aesthetic finish is required. Typical applications include internal wall panelling furniture and fitments, interior door skins and ceiling linings. Interior plywood must not be used in exposed, wet or damp conditions.

Interior plywood to AS/NZS 2270 may have either a type C or type D bond. Both bonds are not durable under full exposure to weather or to wet or damp environments. These bonds are, however, durable under fully protected interior non structural environments.

Type D bonded interior plywood is satisfactory for interior applications under normal conditions of humidity. Type C bonded plywood should be used in high humidity interior environments which may occur locally in areas such as bathrooms or generally in the tropics.

**Exterior** and **interior** plywood are **non structural** plywood and **must not** be used in structural applications. No stress grades can be applied to exterior plywood.

Two face veneer grades are produced for the exposed faces of exterior and interior plywood: A grade designed for clear finishing and B grade designed for painting. Standard grades of exterior and interior plywood are AD and BD.

Higher quality back veneer can be specified if required. For assured performance exterior plywood should be branded with the EWPA plywood “tested exterior” or “approved B-Bond” stamp. Interior plywood should be branded with the “approved interior EWPA plywood” stamp.
Overlaid and Composite Plywood Panels

For various reasons of protection against weather, wear, abrasion and the like, plywood is often overlaid. A variety of overlay materials can be effectively combined with plywood.

High Density Overlays (HDO), probably the best known overlay, is the high density Phenolic resin impregnated paper overlay which is commonly bonded to plywood in the hot press to make plywood for concrete formwork. This overlay affords considerable face veneer protection as well as smoothness to the poured concrete surface. Full details of this product are included in the manual Plywood in Concrete Formwork available for download from the EWPAA web site.

Medium Density Overlays (MDO) are usually a layer of Phenolic resin impregnated fibrous paper. MDO paper surfaces provide an excellent paint surface, particularly for exterior application where a high quality paint finish is required. Surface checking is eliminated by the use of this type of overlay. Medium density overlays are bonded during manufacture of the plywood and are fixed permanently to the face veneer.

Metal Overlays such as aluminium, copper and stainless and mild steels are also applied to plywood. Attaching metals to plywood with adhesive is a specialist job and is performed only under tight quality controlled conditions by manufactures with a high degree of expertise.

Fibreglass Overlays are extremely compatible with plywood and relatively simple to apply. They have many end use possibilities:

- Tanks for storing chemicals when the resistance of the wood is in doubt;
- Liquid storage tanks in general;
- Linings for bins where smoothness is a requirement;
- Waterproofing structures like boat hulls, etc., where abrasion is also factor.

A good example of the use of fibreglass overlaid plywood is in international and smaller sized plywood containers for shipping.

Lead filled plywood is a composite plywood product. The sheet lead can be used within the plywood panel to provide sound proof linings or protection from damaging radiation.

Fibre Cement Sheet Overlays are particularly important in some building applications where the building code requires fire resistance. One way fire resistance requirements can be met using plywood, is in built-up structures which combine plywood and fibre-cement or other acceptable materials, such as plaster.

Decorative Overlays such as vinyl. DAP and melamine, have long been available for interior use. Decorative overlays are obtainable which combine aesthetic appeal, protection against wear, and ease of cleaning and maintenance.
Characteristics of Engineered Wood Products

Structural Engineered wood products have defined and standardised properties. Their strength and stiffness characteristics are therefore totally predictable. The EWPAA/JAS-ANZ product certification brand means that they are also highly reliable.

The engineered wood products that are product certified by the EWPAA are:

- Structural plywood
- Concrete formwork plywood
- Marine plywood
- Laminated Veneer Lumber (LVL) and LVL/plywood I-Beams

(Note: interior and exterior plywood are also Engineered wood products certified by the EWPAA, but they are non structural panel products)

Veneer Arrangement

Each of the engineered wood products that are product certified by the EWPAA are manufactured with specific veneer arrangements to optimise their in-service performance in their intended application.

The manufacturing aspects which differentiate each of the engineered wood products and results in different in-service performance characteristics are:

- Density and species of timber used
- Quality of veneer used
- Thickness and arrangement of individual veneers
- Bond type between veneers

Density and species of timber

The density of plywood and LVL is approximately equivalent to the density of the timber species used to manufacture the product. The density of pine plywood is in the range 500-650 kg/m³. Eucalypt hardwood plywood density can exceed 900 kg/m³ depending on the timber species used.

Generally, higher density species have higher engineering properties. Species of timber may also be chosen to provide a suitable substrate to achieve a high quality finish.

Veneer Quality

The veneer grade used in plywood or LVL will effect its structural performance. The use of all A or B grade veneers in structural plywood will increase its engineering properties by one stress grade. However, usually only higher quality face veneer grades are specified for aesthetic reasons, rather than structural performance.

Marine plywood has high grade face and core veneers to not only allow a high quality finish, but to also increase impact resistance and minimise water penetration through any knots in core veneers. Useful qualities in boat building material! (Note: marine plywood is not waterproof – the final external surface finish provides the waterproof coat).

Veneer arrangement and veneer thickness

The veneer arrangement and thickness of individual veneers within plywood and LVL is critical in determining dimensional stability and the structural performance characteristics of strength and stiffness.

Dimensional stability

Cross lamination of veneer layers restricts the movement across the grain due to moisture and temperature changes. Thus the dimensional stability under moisture content and temperature changes of plywood and LVL products containing cross-laminated veneer will be better than other wood products. The dimensional
stability of LVL containing no cross bands will be similar to the parent timber from which it was manufactured.

Data for calculating the hygroscopic movement of plywood under changes in moisture content is given in the EWPAA design manual “Structural Plywood Commercial and Industrial Flooring”, which is available for download from the EWPAA web site.

**Strength and stiffness**

Generally in plywood panels, the outer most veneers have the greatest influence on strength and stiffness. Increasing the thickness of the face veneers will increase the strength and stiffness characteristics in the face grain direction. Thin face veneer with thicker underlying cross band veneers will tend to give the plywood more equal strength and stiffness characteristics in both directions.

**Structural plywood** usually has thicker face veneer than those used in concrete formwork plywood or marine plywood. Structural plywood transfer load in all directions, however because of the veneer arrangement, most structural plywood has far greater strength and stiffness in the direction of the face grain. It is specified that structural plywood be supported such that the face grain is parallel to the span. Supporting plywood with the face grain direction at right angles to the span is not recommended. (Note: The face grain direction of plywood is normally parallel to the length of the plywood sheet).

**Concrete formwork plywood and marine plywood** usually have thinner face veneers over thicker underlying cross veneers and are designed to have similar strength and stiffness properties in both directions; characteristics that are important in concrete formwork and boats. Actual structural properties for concrete formwork plywood both along and across the grain are specified in the EWPAA design manual “Plywood in Concrete Formwork” which is available for download from the EWPAA web site.

**LVL** usually has unidirectional veneer. That is, all veneers are parallel to the beam length and there are no cross veneers. This optimises its performance as a beam, spanning in one direction.

Note: generally, different plywood types are not directly substitutable for the same application. For example, equivalent stress grade and thickness structural and marine plywoods will not perform the same in a flooring application, due to the fact that marine plywood generally has much thinner face veneers. The structural plywood will usually be stiffer and stronger when supported with the face grain direction parallel to the span, than will the marine plywood.

**Bond Type**

The EWPAA certified engineered wood products are bonded with the Type A phenolic adhesive, except for some concrete formwork plywoods which use lower durability bonds.

NOTE: The bond durability is a different issue to the veneer durability. Veneers may require preservation treatment depending on the intended application of the plywood.

**Resistance to Chemical Agents:** Plywood is relatively unaffected by moderately acidic and alkaline conditions between pH2 and pH10 within normal atmospheric temperature ranges.
Thermal Properties

Thermal Expansion
Wood (and plywood) expand upon heating as do practically all solids. The thermal expansion of plywood is quite small. The average co-efficient of thermal expansion of plywood is $4.5 \times 10^{-6}$ mm/mm/$^\circ$C.

Thermal Conductivity
The ability of a material to conduct heat is measured by its thermal conductivity, $k$. The higher the $k$ value, the greater the ability of the material to conduct heat. The lower the $k$, the higher the insulation value. Thermal conductivity varies with timber species, however an average value of $k=0.1154$ W.m/(m$^2$°C) for softwood timbers is sufficiently accurate for determining the overall co-efficient of heat transmission (U value) of a construction assembly.

Thermal Resistance
The thermal resistance or insulating effectiveness of plywood panels based on $k=0.1154$ W.m/(m$^2$°C) is $R = 8.67$ (m$^2$.°C)/(W.m). The higher the $R$ value, the more effective the insulation.

For example, the $R$ value for 12 mm plywood = $(12/1000) \times 8.67 = 0.10$ m$^2$.°C/W. Similarly, the $R$ value for 25 mm thick pine plywood is $(25/1000) \times 8.67 = 0.22$ m$^2$.°C/W.

Thermal Performance of Timber Framed Plywood Clad Walls
Walls with high thermal mass hold substantially more heat thus continue to radiate heat in the evening. In cooler climates, or if the building is to be air conditioned, the addition of insulation to the timber structure can provide equivalent thermal insulation to solid construction.

For example the addition of R1.5 batts into a plywood clad wall with reflective sisalation on 90mm studs will result in a wall with an average $R$ exceeding 2.2 (see Table 2). Therefore, in winter a lightweight timber wall can be a very effective insulator and keep the warmth inside the building.

<table>
<thead>
<tr>
<th>R Value (m$^2$.°C / Watt)</th>
<th>Through Insulated Zone</th>
<th>Through Stud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outdoor Air Film</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>12mm Plywood Cladding</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>20mm Reflective Air Gap</td>
<td>0.58</td>
<td></td>
</tr>
<tr>
<td>R1.5 Insulation</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>90mm Stud</td>
<td></td>
<td>0.62</td>
</tr>
<tr>
<td>6mm Plywood Lining</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Indoor Air Film</td>
<td>0.12</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Note: As a non-reflective 20mm air gap has an $R$ value of 0.15, an insulated wall system without sisalation would reduce the total $R$ value from 2.36 to 1.93 in the above table.
**Exposure to Extreme Heat**

For plywood used in typical residential and commercial building applications, the relevant thermal performance criteria are usually “fire resistance” and “early fire hazard indices”.

However there may be application where plywood is required to perform under conditions of extreme heat.

There is little effect on plywood used in temperatures below 93 °C and any strength loss due to temperature is recovered when the temperature is reduced.

Plywood exposed to temperature in the range 93 to 150 °C will undergo slow exothermic decomposition evidenced by charring of the wood surface and weight loss. The rate at which this occurs depends upon the temperature and air circulation. Where the appearance of the plywood is important, it should not be used unprotected in temperatures above 93 °C.

In application involving periodic exposure to temperature ranges from 93 to 150 °C, the amount of exposure should be based on the amount of decomposition that can be tolerated before the serviceability requirements of the plywood are impaired. Exposure to temperatures above 150 °C will result in increased charring rates and greater possibility of spontaneous combustion if the heat is not dissipated. At temperatures above 200 °C spontaneous combustion is probable in a short period of exposure time.

**Fire Resistance**

Essentially there are two things to know about fire in connection with plywood used in residential and commercial building applications. These are the meanings of fire resistance and early fire hazard index.

**Fire Resistance** means the ability of a building component to resist a fully developed fire, while still performing its function. Fire resistance in form of a fire rating, can be applied only to a total building element incorporating plywood eg. a fire door or a wall or roof system. A product can not be fire rated.

Plywood is quite acceptable as a material used in fire resistance components or structures providing it is combined with other materials so as to meet the fire resistant requirements. This can be achieved chemically, however the usual method is to combine plywood with non-combustible materials such as fibrous-cement or fire grade plasterboard.

The Building Code of Australia (BCA) is a uniform set of technical provisions for the design and construction of buildings and other structures throughout Australia. The BCA includes a section on Fire Resistance, and designers and builders must ensure that their constructions satisfy this section.

There are 3 categories for plywood used in constructions:

1. Floor Materials and Coverings
2. Wall and Ceiling Linings
3. Other materials.

The following tables list the properties for each of these types. For more information, you can download the “EWPAA Fire Resistance” fact sheet from the [EWPAA web site](http://ewpaa.com.au).
Floor Material And Coverings

<table>
<thead>
<tr>
<th>Species</th>
<th>Thickness</th>
<th>CRF</th>
<th>Smoke Development Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pine, Hoop – Araucaria cunninghamii</td>
<td>15mm or greater</td>
<td>Between 2.2 and 4.5</td>
<td>Less than 750 percent-minutes</td>
</tr>
<tr>
<td>Pine, Radiata – Pinus Radiata</td>
<td>17mm or greater</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pine, Slash – Pinus Elliottii</td>
<td>17mm or greater</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wall and Ceiling Linings

<table>
<thead>
<tr>
<th>Plywood Species</th>
<th>Minimum Thickness (mm)</th>
<th>Group No.</th>
<th>Average Specific Extinction Area (m²/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pine, Radiata – Pinus Radiata</td>
<td>6mm or greater</td>
<td>3</td>
<td>&lt; 250</td>
</tr>
<tr>
<td>Lauan – Shorea agsaboensis</td>
<td>6mm or greater</td>
<td>3</td>
<td>&lt; 250</td>
</tr>
<tr>
<td>Pine, Hoop</td>
<td>6mm or greater</td>
<td>3</td>
<td>82.4</td>
</tr>
<tr>
<td>Pine, Slash</td>
<td>6mm or greater</td>
<td>3</td>
<td>96.0</td>
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Other Materials

<table>
<thead>
<tr>
<th>Face Veneer Common Name</th>
<th>Botanical Name</th>
<th>Spread of Flame Index (0-10)</th>
<th>Smoke Developed Index (0-10)</th>
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</thead>
<tbody>
<tr>
<td>Klinkii pine</td>
<td>Aurancaria hunsteinii</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Radiata Pine</td>
<td>Pinus radiata</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Radiata Pine (scorched and brushed surface)</td>
<td>Pinus radiata</td>
<td>7</td>
<td>2</td>
</tr>
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</table>

Product Quality Certification

The Engineered Wood Products Association of Australia (EWPAA) has operated an industry wide process based, quality control programme continuously since 1963. Approximately 98% of plywood and all laminated veneer lumber (LVL) manufactured in Australia, as well as plywood manufactured by three large New Zealand, one Papua New Guinean and two Fijian companies is quality controlled under this programme. The objective of the programme is to ensure all EWPAA members’ product complies in all respects with the relevant Standards of Australia and New Zealand.

The EWPAA product certification scheme is an industry self help programme consisting of a combination of process quality control and end product testing carried out within each participating mill as well as independent end product testing carried out at the EWPAA’s National Association of Testing Authorities (NATA) registered laboratory. Additionally EWPAA technical staff regularly audit the quality control procedures within participating mills as well as the quality of the end product in the market place.

In 1996 the EWPAA quality control programme gained further recognition through the joint Accreditation System of Australia and New Zealand (JAS-ANZ) which formally accredited the EWPAA as a product certification body for plywood and LVL products manufactured to Australian and New Zealand and was formed via treaty to oversee certification bodies for quality management systems and products.

Plywood and LVL products certified by the EWPAA are branded with the EWPAA product certification stamp as well as the JAS-ANZ mark. The EWPAA-JAS-ANZ brand on a plywood or LVL product certifies the product has been manufactured to the relevant Australian/New Zealand Standard, under a quality control and product certification scheme accredited by the peak accreditation body JAS-ANZ. This means purchasers of products stamped with the EWPAA-JAS-ANZ brand will be purchasing a product manufactured under an accredited third party audited, process based quality control program that ensures the plywood will be fit for
purpose. A list of EWPAA plywood and LVL manufacturing members whose products carry the EWPAA-JAS-ANZ brand is given on the inside back cover, and is also available for download from the EWPAA Web Site.
Preservative Treatment

All timber products, including plywood and LVL, may be subject to decay and/or termite attack under certain conditions. For example, if the moisture content is high enough, the area confined and unventilated and the temperature conducive, fungi can cause decay in most timber species. Direct contact with the ground is extremely conducive to both decay conditions and termite attack.

Correct preservative treatment against fungal attack (rot) is essential for all plywood and LVL products, either painted or unpainted, that are permanently exposed to the weather.

Infestation with termites is usually not a problem for plywood and LVL provided the application does not involve ground contact and other good building practices have been correctly implemented through appropriate design and construction practices as well as ongoing inspection and maintenance.

There are several methods of treating plywood and LVL
(a) impregnation of veneers, prior to manufacture;
(b) pressure treating of the manufactured plywood;
(c) Preservation treating surfaces after manufacture.

A range of preservative treatments are available including copper chrome arsenate (CCA), light organic solvent preservatives (LOSP’s), and the veneer treatments, Ruply and Ammoniacal Copper Quaternary Compounds (ACQ).

Applications requiring treatment and recommended treatment are specified in Australian Standards AS/NZS 1604 parts 3 – “Specification for preservative treatment for plywood” and AS/NZS 1604 part 4 – “Specification for preservative treatment for LVL”. AS/NZS 1604 specifies six hazard level classifications. Each level is denoted by a hazard number from H1 to H6, with each hazard level defined in terms of specific service exposure. H6 is the most severe hazard level.

Plywood with a Type A bond used as exterior cladding must be treated against fungal and insect attack. The preservation treatment should be a minimum of hazard level H3 “outdoors above ground” as defined by AS/NZS 1604.3.

Pressure treatments of the manufactured plywood are envelope type treatments, that is, the outer veneers, edges and ends of the sheet are preservative treated. However, the preservative may not have penetrated through the glue lines to the middle veneers of the plywood. If the plywood is cut, then localised paint on preservative treatment is required to the cut edge.

Veneer preservative treatments treat each individual veneer prior to assembly of the product and no further treatment should be required if this type of preservative treated product is cut.

Preservative treating plywood or LVL after manufacture or surface treating with “brush on” preservatives should be done, if possible, only after machining, sawing and boring of the plywood or LVL has been completed.

It is difficult to bond some preservation treated plywood particularly with phenolic or resorcinol adhesives.

Preservative treated plywood and LVL is suitable for painting provided manufactures recommendations are followed and the surface to be painted is dry and free of excess solvent or salts. Details are given in the Exterior finishing section.
Knowing the conditions under which the plywood or LVL is to be used is essential if correct advice on the type of treatment required is to be determined. The CSIRO, EWPAA and preservative treating companies are further sources of information on recommended treatments.

Fasteners used with preservative treated plywood should be hot dipped galvanised or have equivalent corrosion protection. Stainless fasteners may be required for severe exposure applications.
**Interior Finishing**

EWPAAN Tested and approved plywood A and B quality face veneers, appropriately sanded, have a surface designed to provide a satisfactory substrate for high quality finishing with interior finishes, stains and paints. The A quality face is suitable for clear finishing. The B quality face veneer is suitable for painting. Under normal protected interior applications type D or C bonded plywood will give long term durability and preservative treatment is not necessary.

Before finishing ensure the plywood is dry (below 12-15 percent moisture content) and the surface to be painted is clean, smooth and wax free.

Clear finishing, French polishing, staining and painting of plywood with a wide range of materials is readily achievable for interior applications. Best advice is to follow paint manufacturers directions.

The use of high gloss finishes and paints tends to highlight naturally occurring and manufacturing characteristics of plywood such as beat marks from sanding, knots and open defects in underlay veneers, grain variation and patches, and is therefore not usually recommended. Stain and matt finishes and paints give a high quality aesthetically pleasing surface and are recommended.

**Single pack polyurethane** clear in a satin or matt finish is recommended for most interior plywood surfaces such as wall panelling, furniture and fitments. A high gloss finish may be used on table tops, however naturally occurring and manufacturing characteristics may be highlighted as noted above. This finish is extremely durable in the fully protected interior environment and is resistant to heat, alcohol and household chemicals. A recommended procedure for applying a single pack polyurethane satin or matt finish is:

(a) Sand the plywood with a very fine sandpaper. Sand in the direction of the grain never across it.
(b) Apply one coat of the polyurethane satin or matt finish by brush, not roller. Do not brush vigorously as this will cause bubbles. Simply lay the finish on the plywood surface.
(c) Allow the finish to dry thoroughly. Ensure at least the minimum time recommended by the finish manufacturer has elapsed.
(d) Rub down the surface with steelwool to remove the nibs
(e) Apply a second coat of finish.

An extremely high quality finish can be achieved with this method.

**Two pack polyurethanes**, which are normally high gloss, produce an exceptionally hard, durable coating for interior plywood surface where extreme resistance to abrasion or chemical action is required. Applications such as laboratory bench tops, school decks and decorative flooring require this type of hardwearing finish.
There are newly developed clear finishes formulated on acrylic polymer systems. They are fast drying and should not be rubbed down between coats. They are non yellowing due to the inclusion of ultraviolet filters but are intended for interior use only and should not be used on areas subjected to direct heat or extreme wear such as floors and bench tops. These finishes have the advantage that brushes and equipment can be cleaned using water.

**Oil based stains** are pigmented wood stains designed to give an even toning of all timbers including species such as plantation pines with unevenly porous surfaces which give patchy results with dye type systems. The traditional spirit based stains used by craftsmen for many years are deeply penetrating stains for use on darker species and Tasmanian Oak. Oil based stains are recommended for the amateur. Both these stains require a top coat of clear finish.

A wide range of wood grain fillers and sanding sealers are available to assist in attaining a high quality finish on decorative plywood. Paint and finish manufacturers literature is readily available and should be consulted.

Clear finishes on light coloured plywoods tend to yellow with age. Yellowing can be minimised by a number of methods.

(a) Use modern formulations of finish which incorporate ultra violet filters, eg. Single pack polyurethanes, sometimes called “pine finish” and acrylic based formulations are readily commercially available.

(b) Surface such as Victorian ash and Tasmanian oak can be bleached prior to the application of a finish containing ultra violet filters.

(c) Small portions of white pigment can be added to clear finishes which act as ultra violet absorbers.

It is extremely good practice to experiment with samples to establish the final colour when staining or clear finishing plywood.

**Exterior Finishing**

All fully exposed plywoods must be surface finished to prevent mechanical surface breakdown, known as surface checking or crazing, caused by the absorption and desorption of moisture through the surface veneer. In addition it must be stressed that all plywood used in externally exposed conditions must be Type A bonded and preservative treated to ensure long term durability and performance.

The plywood surface may be finished by:

- painting,
- coating with water repellents or,
- Overlaying with medium density phenolic impregnated papers.

Plywoods with an A or B grade face veneer quality and appropriately sanded have a surface designed to provide a suitable substrate for a high quality paint or stain finish. Plywood with C or D quality face veneer is not designed to provide a high quality paint substrate.

Plywood cladding products are also available with a machined or textured face which provides an excellent surface for paint or stain adhesion as well as disguising any surface checking of the veneer.

Generally, sanded or textured surfaces, clear of defects, are the most suitable for painting. Jointed surfaces do not provide paint problems, but patches and plugs which tend to move independently can cause a paint failure.
The EWPAA has shown through full exterior exposure trials that 100 percent acrylic latex paint systems perform best on plywood. The satisfactory **acrylic latex paint system** for plywood comprises:

- One coat of 100 percent acrylic stain blocking primer, and
- Two coats of acrylic latex exterior top coat.

**Rigid paint systems**

Rigid paint systems including oil based and alkyd enamel paint systems are **not recommended** for use on plywood in weather exposed applications. Rigid paint systems form a hard brittle coat which is prone to checking from any movement of the plywood due to moisture or temperature. Rigid paint system can however, be used on medium density overlaid plywood.

Light paint colours are recommended in performance to darker colours. In humid areas where mould may grow on the paint surface, the use of a mouldicide in the paint is strongly recommended.

The acrylic latex paint system is compatible with most current plywood preservative treatments. Any CCA deposits (a green to white powder) on the surface of CCA treated plywood should be cleaned by scrubbing and hosing. Allow to air dry before painting.

LOS treated plywood should be allowed sufficient time to air before painting, to allow solvent to evaporate. A week is normally sufficient or as specified by the manufacturer. (Until there is no greasy feel).

As preservative treatment formulations change, the compatibility of the paint system should always be checked with the treated plywood supplier. For example, some new formulations of CCA and LOSP contain waxes and water repellents which are incompatible with acrylic paints.

If a natural look is desired exterior water repellents stains are recommended. Two products which have given good trail results under fully exposed conditions are Celtite exterior water repellent stains and Cuprinol water repellent. Both products are compatible with preservative treated plywood.

It is seldom wise to recommended clear finishes in exposed conditions if a lasting finish is required. Even the most modern acrylic clear finishes will not stand up to sun and weather without constant and excessive maintenance.

**Medium density overlaid plywoods** may be painted with a range of oil and water based paint systems. Rigid oil based paint systems can be used on overlaid plywood because the overlay acts to prevent surface checking of the plywood face veneer. The following systems have proven to be satisfactory:

- **Oil based**
  - 1 coat alkyd primer
  - 1 coat oil based undercoat
  - 2 coats oil based exterior gloss

- **Oil/water based**
  - 1 coat alkyd primer
  - 2 coats acrylic top coat

- **Other rigid exterior paint systems** such as pigmented epoxies.
- The full acrylic paint system is also satisfactory for use with medium density overlaid plywood.
**Edge sealing**
Although not a mandatory requirement for exterior exposed plywood panels, edge sealing is considered good practice as it minimises moisture uptake through the panel end grain which in turn reduces both localised swelling and the tendency to surface check at edges.

**Sealing the back side or unexposed surface** of exposed plywood on an immovable frame is unnecessary from a stability viewpoint. The practice of water sealing plywood backs was recommended to prevent water penetration, however, it was found in fact to increase the incidence of fungal attack by trapping moisture in the panel. Fungal attack in exterior exposed plywood is controlled by using preservative treated plywood.

In some applications such as garage door, it is good practice to seal both surfaces.

**Paint Quality**
Always use top quality paints. Quality is more important than cost, because cost of application and maintenance are much higher with inferior quality paints. Painting plywood for exterior paints are applied according to the paint manufacturers directions.

**Plywood Orientation**
It should be noted that horizontal surfaces present a greater hazard to paint breakdown and surface checking than vertical surfaces. This is particularly so if the surface are subjected to traffic. The finishing requirement will vary depending on the life expectancy and the quality requirements. Solutions vary from covering plywood with an outdoor carpet to painting medium density phenolic impregnated paper overlaid plywood with non slip filled epoxy paints. Check the requirements and seek advice from the paint supplier or the EWPAA technical staff. Plywood with factory applied ‘non-slip’ overlays are available from limited supply sources.

It is also recommended that the “Technical Note on Plywood For Exterior Decking” be reviewed for more information on this topic. This document is available for download from the EWPAA web site.

**Residential Building Applications**

**Structural Plywood** used in residential flooring, bracing, webbed beams or non trafficable roofing should comply with Australian/New Zealand Standard AS/NZS 2269.0 : Plywood Structural and be branded with the EWPAA tested Structural Plywood stamp. Non structural cladding or linings should be branded with either the EWPAA Tested Exterior or EWPAA Approved Interior stamps as appropriate.

**Structural LVL** used for floor joints and bearers, lintels and roof beams, must comply with the Australian New Zealand standard AS/NZS 4357.0 Structural Laminated Veneer Lumber, and should be product certified by the EWPAA.

The use of structural plywood as residential flooring, bracing and non-trafficable roofing is covered in AS 1684 National Timber Framing Code which is “deemed to comply” under state building ordinances and the Building Code of Australia. Additionally, full details on the use of structural plywood in these applications are contained in the EWPAA technical literature available from the EWPAA web site:

- T&G Structural Plywood for Residential Flooring
- Timber Tops for Concrete Slabs
- LP91 Low Profiled Stressed Skin Plywood Floor System
- Structural Plywood Wall Bracing – Limit State Design Manual
- Featuring Plywood in Buildings
- Structural Plywood and LVL Design Manual
- Shelving Design Manual
Full specifications including low span tables for plywood webbed lintel, strutting and combined strutting and hanging beams, which are independently engineer certified, are contained in the manual

- **Plywood Webbed Structural Beams for Domestic Housing.**

**LVL Framing**

Structural LVL is used as a framing material in many domestic dwelling applications. It is commonly used for floor joints and bearers, lintel beams and roof framing beams. Structural LVL has many advantages when used as a framing member including high structural reliability and strength, uniform and true cross section with a little tendency to wrap, bow or twist and availability in long straight lengths.

**Flooring**

The dimensional stability and permanent Type A phenolic bond of EWPAA branded, plastic tongued and grooved, structural plywood makes it a structural safe and reliable floor for residential dwellings. Structural plywood is approved for use as flooring in wet areas of dwelling such as bathrooms. The one plywood product can be used throughout the entire floor which adds to economics and avoids confusion. The permanent Type A bond and dimensional stability also make T&G structural plywood eminently suitable for flooring using the platform construction technique.

**LP91 Low Profile Plywood Floor System**

An alternative platform floor system is detailed in the EWPAA manual LP91 Low Profile Stressed Skin Plywood Floor System. The low profile plywood floor system utilises composite action between the structural plywood flooring skin and the LVL or seasoned pine joists and bearers. This floor system is performance and cost optimised.
Plywood flooring can be covered directly with a wide range of floor coverings including, vinyl, cork, linoleum and carpets.

There is no need for expensive underlays. The tongued and grooved panel edges eliminate the need for nogging.

T&G plywood flooring is available in a range of thickness, stress grades and lengths to suit standard joist spacings of 450, 480 and 600 mm.

Under normal circumstances structural plywood flooring does not require preservative treatment. It should be remembered however that all plywood used in semi or fully exposed environment must be preservative treated.

**Bracing**

The use of plywood in timber framed buildings provides designers the opportunity of having flexibility in designs, i.e. large openings and areas of glass in external walls whilst simultaneously providing structural adequacy in the remaining short walls. This is an advantage in non-cyclonic as well as cyclonic areas.

Plywood bracing, when installed using the allowable unnotched section sizes of stud allowable in AS 1684 – Residential Timber-Framed Construction Code, is an extremely economical method of bracing any house frame.

It is most important that all requirements relating to the fixing of the structural plywood to the frame be adhered to strictly.
Plywood Webbed Beams
Timber flanged plywood webbed box and C section beams are stable, lightweight and cost effective particularly in lintel beams with spans in the range 2.1 to 3.6m. These fabricated beams with remain viable as large section timbers of suitable quality and length become difficult to obtain.

Plywood webbed lintel, strutting and combined strutting and hanging beams can be fabricated using a nailed only connection between the timber of LVL flanges and the plywood webs.

Lintel beams can be fabricated as part of the timber frame by connecting a normal framing size timber head to the top plate with nailed plywood webs.

Roofing
Structural plywood is approved in AS1684 as a non trafficable roofing. The structural plywood can be surfaced with a wide range of water proofing membranes from felt and tar which is used in the USA for industrial buildings to elegant and attractive fibreglass reinforced roofing shingles. Fibrous cement shingles and timber shakes are also suitable surfaces for application to plywood roofing. Manufacturers recommendations must be strictly adhered to for surfacing products.

Structural plywood roofing may have a decorative underside which can be grooved to give an aesthetically pleasing planked effect. The roofing can therefore be used as an exposed ceiling.

Cladding
A wide range of plywood products exist that can be used as external cladding. For maximum economics it is a good idea to use structural plywood for bracing and cladding combined.

All plywood external cladding must be preservative treated against fungal attack.

To minimise surface checking the plywood must be either overlaid with a medium density phenolic impregnated paper, or painted with acrylic paint systems or water repellents as detailed in the section Exterior Finishing.

Typically plywood cladding products are manufactured to suit 1200 mm cover hence wall studs need to be at 600 mm or 400 mm centres.

Interior Wall and Ceiling Linings
Plywood with a high quality face veneer can be clear finished to give a real timber appearance to walls, ceiling and eaves lining on verandahs.

Plywood can be specified with V grooved faces to give a traditional planked effect and it can be curved for feature ceilings and walls. Further details including acoustic and thermal performance of plywood claddings are given in the EWPAA publications “Featuring Plywood in Buildings” and “Structural Plywood and LVL Design Manual” available for download from the EWPAA web site.

Plywood in Domestic Wet Areas
Only plywood with permanent type A bond should be used in the construction of fitments around sinks and vanity units.
Commercial and Industrial Structural Building Components

EWPA product certified structural plywood and LVL are eminently suitable for use in structural components in commercial and industrial structures. They have a permanent type A bond and are manufactured under a rigorous product quality certification scheme ensuring product compliance with Standards and defined engineering properties essential for reliable and safe design.

Structural LVL and plywood components include:

- Industrial and Commercial floor systems
- Stressed skin panels
- Box and C section beams
- Arches
- Gussets
- Portal frames
- Bracing walls (shear walls)
- Structural diaphragms
Structural plywood should be ordered unsanded for components where structural performance alone is critical. Structural plywood is normally supplied unsanded for D grade faces and sanded for A, S, B and C grade faces.

Usually DD grade structural plywoods are satisfactory for structural use components in industrial applications. This grade of plywood provides the best performance/cost ratio. Higher face grades are available which provide more aesthetically pleasing surfaces. Structural plywoods with highly decorative face veneers or A grade faces suitable for clear finishing can be used in structural components such as gussets in exposed trusses in churches.

Eight stress grades of structural plywood are detailed in AS/NZS 2269.0 ie. F7, F8, F11, F14, F17, F22, F27 and F34. Each stress grade is equally satisfactory for use in structural components and industrial applications. The higher the stress grade of plywood, the thinner the plywood requirement will be to perform the same structural function.

Structural plywood section properties.
Section Modulus (Z) and Second Moment of area (I) in addition to engineering properties and load modification factors are contained in AS 1720 part 1, AS/NZS 2269 part 0, and the EWPAA publication “Structural Plywood and LVL Design Manual”.

LVL engineering properties and section properties are published by the individual manufacturers.

Physical properties such as dimensional stability under changes of temperature and moisture content, surface characteristic, face grades, standard dimensions and branding are specified in EWPAA publication “Structural Plywood – Design Manual”.

Connections
Components may have a glued or nailed engineered connection. If glued connections are used the bond must be produced using a resorcinol or natural or synthetic phenolic/resorcinol formaldehyde rigid, thermosetting adhesive. Nail loads are to be computed using the values for plywood to timber joints given in AS 1720 part 1 Timber Structures Code.

Design
Structural components must be designed by a qualified structural engineer and must be fabricated under a strict quality control program. Engineering advice is available from EWPAA Technical Staff.

Preservative treatment
If plywood or LVL in structural components is to be exposed to the weather or a wet or damp environment, then the product must be preservative treated against fungal attack. Fasteners must be compatible with the preservative salts. Under exposed conditions the structural plywood must be surface coated with an appropriate overlay, water repellent or paint to avoid surface checking and mechanical degrade. See the section on Preservative Treatment for more information.

Industrial Flooring
Structural plywood has defined and standardised engineering properties and therefore is suitable in flooring systems designed to withstand the higher loads required in commercial and industrial flooring applications. Note: Industrial floors subjected to hard wheel or castor traffic will require an appropriate floor finish wearing surface to resist damage. Full details, including load span data, for the use of structural plywood in commercial and industrial floors are contained in the EWPAA publication “Structural Plywood for Commercial and Industrial Flooring Design Manual” available for download from the EWPAA web site.
Engineered Timber Floor Systems utilising LVL, I beams and plywood flooring are an extremely economical flooring solution for commercial, industrial and other heavy load applications.

Materials Handling Applications

The permanent Type A phenolic bond and known and reliable structural properties of EWPAA tested structural plywood make it ideally suited for applications in materials handling, pallets, shelving, containers, bins and transport equipment.

Structural plywood has some physical and structural characteristics that can be used to advantage in materials handling applications:

- high strength and stiffness to weight ratio
- high puncture resistance
- resistance to impact and short term overloads
- improved dimensional stability under changes in moisture content
- two way strength and stiffness
- ease of repair

Pallets

Structural plywood used for solid deck pallets results in a high quality, high strength, light weight pallets. In service case studies of captive type pallets have shown in many applications plywood pallets last substantially longer than solid timber pallets, sustain less damage, require less maintenance, offer greater protection of goods and are extremely cost efficient. Plywood pallets may have a higher initial capital cost than solid timber pallets, however they are usually far more cost effective due to:

- low pallet maintenance and repair cost
- longer pallet life span
- less damage to goods on pallets

Shelving

Structural plywood is an ideal shelving material. It is strong yet lightweight and its cross-laminated structure gives it an inherent two way strength, impact resistance and dimensional stability. Structural plywood panels products certified by the EWPAA are precision panels. They have highly predictable strength and performance characteristic that permit economical shelving design solutions, as panel stress grade and thickness can be selected to suit the application.

Containers

Structural plywood is regularly used for containers for transportation of goods. It is used to containerise a wide variety of goods from whole cars for export, to delicate electronic components.

Many containers have special requirements that require engineering expertise in their design. In some cases containers may be designed using standard timber engineering design methods prescribed in AS 1720. In most cases however, to optimise the plywood usage and to ensure correct performance under actual conditions of use, prototypes need to be constructed, tested, placed in service and monitored.
Appropriate plywood selection will also depend on the user requirements for expected life span, surface appearance and finishes, conditions of use eg. permanently exposed or protected connection details, waterproofness, linings and maintenance. Once end use requirements are clearly defined a specification for the plywood to meet the end use requirements should be prepared and agreed upon by all parties. The EWPAA technical staff can provide assistance.

Bins, silos, bulk handling units and container floors in plywood are popular. Plywood is a feasible material for the local builder and/or company maintenance department. Good design and a clear understanding of the end users actual needs is again essential.

Chutes, flumes, tanks, water towers are all valid plywood uses. Preservative treatment knowledge and surface protection requirements are prerequisites for the use of plywood in these applications.

Trays, small containers, boxers and bins for internal handling of small items in factories and manufacturing can be readily fabricated from plywood.

Finishing
The plywood surface may require finishing depending on the expected life of the product and the environment in which it will operate.

On Site Applications
EWPAA product certified structural and exterior plywoods have many applications on the building site. Structural plywood with its defined for structural properties can be safely and reliably designed for structural applications. Excluding concrete formwork which is covered separately, these include:

- structural ramps
- overhead protective barriers
- housing for tools and implements
- runways
- protective partitions for saws and welding areas

Note: Exterior plywood should only be used in non structural applications.

When properly specified, installed and protected structural and exterior plywoods are “all weather” materials. They readily absorb site abuse and do not damage easily when roughly handled nor puncture easily under impact.

In most site applications labour cost is a factor in favour of plywood. In-place cost and speed of erection are particular plywood advantages; in addition it can be worked with standard carpenter’s tools. Specialised equipment is not required. Further details are provided in the section titled “Fixing and working”.

Structural requirements, bond durability, preservative and finishing requirements must be considered for each application. Correct plywood specification is essential to ensure its safe and reliable use in any site application. Contact the EWPAA technical staff if you require assistance.

Temporary site buildings are readily constructed with reusable Type A bonded structural and exterior plywood panels.

Hoardings around the site are an excellent application for either structural or exterior plywood. Hoarding can be reused at the next site. Hoardings can be made attractive simple by painting and can be used to advertise the building, or building related matters.
Do It Yourself

The range of standard EWPAA project certified plywoods are suited to a wide range of Do It Yourself (DIY) projects.

To ensure satisfactory performance, correct decisions must be made about plywood type, treatment, installation requirements and finishing relative to the particular DIY application. These notes, together with EWPAA publication “Plywood Ideal for the Professional and Home Handyman” contain advice which will aid proper selection.

The EWPAA plywood products range fits the DIY users needs in large projects. These include flooring, wall bracing and cladding applications in owner built dwellings for which detailed instructions are included in the EWPAA technical design manuals.

Wall and ceiling linings are covered in the EWPAA manual “Featuring plywood in buildings” available for download from the EWPAA web site.

Marine plywood remains the ideal product for the DIY boat builder.

Decorative plywoods are available for wall panelling and built-in fitments. These interior plywoods should be used in interior, fully protected environments.

Type A bonded structural plywood is an ideal material for applications ranging from cladding the dog kennel to the letter box. Remember the finishing and treatment advice must be followed.

EWPAA product certified plywood products are both safe and reliable. For free DIY plans, visit the EWPAA web site.

Fixing and Working

EWPAA product certified plywood and LVL can be sawn, drilled, shaped, nailed, screwed and glued like regular wood, using simple carpenter’s tools. Because of the cross laminated construction of plywood, it can be nailed close to the edge (within 7 mm for plywoods up to 7 mm thick and 10-12 mm for thicker plywoods), without fear of splitting. This characteristic is used to advantage in applications such as plywood bracing and nailed plywood webbed beams.

Standard plywood products are manufactured with a “balance” construction to build in panel stability. No plywood panel, however, will stay entirely flat under all ambient conditions if left free to move. Warping, bowing and twisting can occur due to moisture imbalances, unbalanced laminates or paint coats or unbalanced stresses, it s strongly recommended therefore that regardless of thickness, plywood should always be positively fixed to supports.

Depending on the type of supports, plywood can be fixed with standard fasteners. Full fixing requirements are detailed for plywood bracing, flooring, roofing, claddings, linings and webbed beams in EWPAA Technical
literature. Plywood to timber support connections can be made with standard nails and wood screws. In arduous applications or where low joint strength species are used as supports such as plantation pines, Oregon and spruce pine fir (SPF), deformed shank nails are recommended.

The availability of reliable engineering data on nailed timber to plywood joints in AS 1720 and the development of nailing guns has revolutionised the potential of plywood in fabricated components such as webbed channel and box beams, gussets in tableforms and domestic floors. Safe, economical and extremely reliable joints can be now site manufactured with machine driven nails.

In plywood to steel support connections self drilling and tapping screws are recommended. It is often beneficial in applications such as flooring to use structural elastomeric adhesive as well as mechanical fasteners to eliminate such occurrences as squeaky floors.

**Bending plywood** is relatively simple. Plywoods with Type A bond phenolic glue lines can be soaked or steamed to assist bending. Minimum safe bending radii without soaking or steaming are obtainable from the EWPAA technical literature. It is not possible to obtain a compound curve when bending flat plywood panels.

**Moulded plywood** is required for unsupported bends or compounds curves. Moulding is controlled in the manufacturing process. A small number of specialised manufacturers produce moulded plywood.

**Factory manufactured scarf jointed** plywood is available from limited sources. The scarf joint is fabricated with the same bond durability and quality as the plywood. Testing in CSIRO has shown that the panel stiffness is unaffected by scarfing (compression and shear stresses are also unaffected). However, allowable bending stresses must be reduced by a 0.8 multiplying factor.

**Glue fixing**

The control required for successful gluing with resorcinol type adhesives precludes its recommendation for site gluing application. These rigid permanent adhesives have no gap filling properties and require 0.8 to 1.0 MPa pressure to bring surfaces together for successful bonding. This is almost impossible to achieve on site. Additionally the use of resorcinol formaldehyde adhesives requires close control over timber moisture content, temperature and open and closed assembly times all of which may be difficult or impossible to control on site. Resorcinol adhesives must only be used under factory type control. A good rule is to use mechanical fixing for site connection and resorcinol adhesive where fabrication is carried out under factory conditions.

Structural elastomerics are very tolerant and can be used on site to fix flooring panels to joists.

**Storage of plywood and LVL** should always be in a dry sheltered position, covered from sunlight. Plywood panels should always be stored flat on rails, with the top panel protected from changes in moisture conditions. Do not lean panels against a wall or the side of the rack for any period of time.
# Revision History

<table>
<thead>
<tr>
<th>Revision</th>
<th>Changes</th>
<th>Date</th>
<th>Who</th>
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<tbody>
<tr>
<td>4</td>
<td>• Updated logos and member list</td>
<td>06-02-12</td>
<td>MB</td>
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| 3.0      | • Clarified the fixing distances in the “Fixing and Working” section.  
           • Updated the logos.  
           • Updated the last page. | 12-10-10 | MB |
| 2.0      | • Reformatted.  
           • Several small grammatical changes, and clarifications.  
           • Images updated, and hyperlinks added to document. | 27-10-08 | MB |
| 1.0      | Initial Release | 27-10-08 | MB |
### Plywood and Laminated Veneer Lumber (LVL)

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<tr>
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### Particleboard and MDF

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