

EWPA

## TONGUED AND GROOVED RESIDENTIAL FLOORING

Plywood specifications, design data, and detailed installation requirements for use of T&G structural plywood as flooring in residential buildings.

# TABLE OF CONTENTS

<b>Introduction .....</b>	<b>3</b>
Benefits of EWPA Structural Plywood Flooring .....	3
<b>Structural Plywood Specifications.....</b>	<b>4</b>
Durability.....	4
Stress Grades.....	4
Face and Back Grades .....	4
Dimensions and Tolerances .....	4
Tongued and Grooved Edges .....	5
Branding .....	5
Plywood Characteristics .....	5
<b>Installation.....</b>	<b>6</b>
Insulation (R-values) For Plywood Floors .....	6
Fixings.....	7
Floor Installation .....	8
Sub-Floor Ventilation .....	9
Finishing .....	9
<b>Wet Area Flooring .....</b>	<b>9</b>
Fixing .....	9
Approved materials.....	10
Floor to Wall Junctions.....	10
Floor Joints .....	10
Wall to Wall Junctions.....	10
Sealing the Plywood Floor Surface .....	11
Floor Waste and Shower Outlet.....	11
<b>Revision History.....</b>	<b>12</b>

# Introduction

Over the last 30 years in Australia EWPAA tongued and grooved structural plywood has proved to be a structurally safe and reliable floor for residential dwellings. It is lightweight and easy to install, retains the comfortable feel that timber floors offer, and although structural plywood can be installed as a fitted floor, it is particularly suited to platform construction techniques. Structural plywood flooring described in this publication more than satisfies the domestic floor loading requirements as specified in AS/NZS 1170.1 “Structural Design Actions – Permanent, Imposed and Other Actions” and is incorporated in AS 1684 – “Residential Timber – Framed Construction.

Structural plywood stamped with the “PAA” quality stamp is an engineered structural product where timber veneers are permanently cross-laminated together using the permanent Type A bond. This bond uses phenolic resin and forms a permanent glueline that will not deteriorate under long term stress or wet conditions. It is the only proven long term structural bond for timber products.

This design manual provides the relevant plywood specifications, design data, and detailed installation requirements for use of T&G structural plywood as flooring in residential building including nominated wet areas. For information on other uses of T&G structural plywood please refer to EWPAA “Structural Plywood for Commercial and Industrial Flooring – Design Manual”.

## Benefits of EWPAA Structural Plywood Flooring

- **Durability** – The permanent Type A ‘Marine’ bonds have been proven to perform in a full exterior environment for at least 50 years. Structural plywood is therefore most acceptable as flooring in ‘wet areas’ such as bathrooms and laundries.
- **Code Acceptance** – Structural plywood flooring is incorporated in the Residential Timber – Framed Construction Code and is therefore approved by building and lending authorities.
- **Lightweight** – Plywood flooring has superior strength and stiffness for its weight and is **easily installed by one person.**
- **Comfort and Strength** – The comfortable feel of plywood flooring belies the tremendous reserve of strength.
- **Dimensional Stability** – Plywood’s cross-laminated construction provides excellent dimensional stability if exposed to the weather during the installation period.
- **Impact Resistance** – Plywood resists edge damage and impact damage during installation.
- **Bracing Diaphragm** – Plywood flooring may be used as a structural diaphragm to transfer wind loads to bracing elements.
- **Versatility** – In second storey floor exposed beam applications, plywood may be used as a combined floor and decorative ceiling.
- **Safety and Reliability** – EWPAA ‘Tested’ stamped panels are quality controlled through a JAS-ANZ accredited, third party audited, industry wide process based quality controlled program, and have proven reliability.
- **Environmentally Friendly** – Plywood is made from a natural product - wood - which is a renewable resource, and requires limited use of energy in its manufacture.

# Structural Plywood Specifications

All EWPAA T&G plywood panels are manufacture to AS/NZS2269 – 2004 “Structural Plywood” and must be stamped with the EWPAA JAS-ANZ ‘Tested Structural’ quality control stamp. The EWPAA JAS-ANZ stamp assures that the plywood has been manufactured under the JAS-ANZ accredited EWPAA third party audited, process control based, quality control program, to the Australia Standard AS/NZS 2269.0 “Structural Plywood”.

## Durability

All structural plywood manufactured to AS/NZS2269 has the permanent Type A ‘marine’ bond. This bond is achieved using a phenolic adhesive which is distinctively dark in colour. The bond test for Type A gluelines involves a 72 hour continuous boil in water, which has been proven to simulate over half a century of actual exposure, without glueline breakdown. As full exposure during the construction period doesn’t affect bond durability, plywood flooring is ideally suited to platform construction techniques. Additionally, this proven bond durability makes structural plywood flooring well suited for floors in wet area rooms. **Standard structural plywood flooring is not recommended for permanently exposed verandahs and decks.** If permanent exposure is required contact the EWPAA for additional product and installation data.

## Stress Grades

Standard T&G structural plywood flooring for residential applications is readily available in two stress grades, F11 and F14. Plywood flooring thickness, stress grade and allowable span details for residential floors are provided in Table 1. Plywood flooring panels with higher stress grades, F17, F22, F27 and F34, are available for commercial and industrial flooring applications. Tabulated data for commercial and industrial flooring applications with higher load requirements is detailed in the EWPAA publication “Structural Plywood for Commercial and Industrial Flooring – Design Manual”.

## Face and Back Grades

The standard face grade for T&G structural plywood is ‘C’ which is a non-appearance grade with a solid surface. The face is particularly suitable for direct covering with a wide range of floor coverings such as vinyl or cork. The standard grade for the back of the panel is ‘D’. The D grade surface can contain open defects such as knots, holes and splits. Standard T&G plywood panels are specified as CD grade.

T&G structural plywood is also available with C grade face and decorative, usually grooved back which gives a real wood planked timber effect, suitable for applications where the panels are to be used as a combined floor and ceiling or as a structural non-trafficable roof.

## Dimensions and Tolerances

T&G structural plywood is available in sizes to suit 400, 450, 480 and 600mm joists spacing’s. Shown below are the common sizes, however, regional factors may influence the availability of some of these:

2250mm x 1200mm  
2400mm x 1200mm  
2700mm x 1200mm

The above dimensions are the actual panel cover; the first dimension is the length of the panel along the face grain, the second being across the grain.

The tolerance on length and width is  $\pm 1.5$ mm.

The standard thicknesses of T&G structural plywood varies between manufacturers. Therefore, it is best to check both the thicknesses and panel sizes available through the EWPAA plywood merchants.

The tolerance on stated thickness is  $\pm 4\%$ .

### Tongued and Grooved Edges

T&G structural plywood is tongued and grooved along the length of the panel to eliminate the need for noggings under panel edges. Panel ends are not tongued and grooved and must therefore be completed. Based on full scale prototype testing, the tongued and grooved edge has a design load capacity of 7.5kN point live load mid span. The T&G edge is suitable therefore for all residential flooring applications.

### Branding

All EWPAA quality controlled T&G structural plywood is branded as follows:

- Manufacturers Name or Brand
- The word 'Structural'
- Face grade, back grade and bond, eg. CD-A Bond
- Stress Grade, eg. F11 or F14
- The Australian Standard AS/NZS 2269.0
- The panel construction code eg. 15-30-5
- The Formaldehyde Emission Class, eg. E<sub>0</sub>
- The EWPAA JAS-ANZ 'Tested Structural' stamp



### Plywood Characteristics

Structural plywood flooring is capable of carrying many times the 1.5kPa uniformly distributed imposed load as required by the Australian SAA Loading Code for the general floor areas of the houses. As residential flooring, the minimum thickness for plywood is limited by panel stiffness which provides a comfortable feel. The density of pinus plywood is around 550kg/m<sup>3</sup> which means a 2250mm x 1200mm x 15mm panel weighs about 22kg.

Even though plywood possesses excellent dimensional stability, if it gets wet during the construction phase a little hygroscopic movement can occur. However, as the natural wood structure is maintained during plywood manufacture all moisture movements for practical purpose can be considered **reversible**. Panels should be pushed together lightly by hand, cramping is not recommended.



# Installation

Sub-floor beams and joists must be sized and installed in accordance with AS1684 “Residential Timber – Framed Construction”. Table 1 sets out recommendations included in the Code, for the minimum allowable thicknesses of F8, F11 and F14 stress grades of structural plywood over standard joist spacing’s in residential flooring applications. The minimum thicknesses are suitable for trafficable floors in residential applications with occupancy requirements of concentrated live loads of 2.7kN (which is detailed in AS1170.1 “Structural Design Actions – Permanent Imposed and Other Actions”).

**Table 1 - Minimum Allowable Plywood Thicknesses for Residential Flooring Applications**

Standard Joist Spacing’s (mm)	Minimum Allowable Thicknesses (mm)		
	F8	F11	F14
400	12	12	12
450	14	13	12.5
480	15	14	13
600	19.5	18.5	17

**Notes :**

1. 15mm F11 of 14mm F14 provide equivalent stiffness to 19mm particleboard at 450mm joist centres. If the plywood is to be overlayed with large ceramic tiles to minimise likelihood of cracking of the brittle tiles, use 17mm F11 or equivalent at 450mm joist centres, or use the bonded mortar bed system detailed for wet area flooring.
2. Stress grades vary between manufacturers. Best to check availability before specification.
3. The plywood must be installed as seen in Diagram 1.
4. The plywood face veneers must not be thinner than any or all of the veneers. If the faces are thicker than any or all of the veneers, then the values in this table will be slightly conservative.

## Insulation (R-values) For Plywood Floors

Plywood flooring provides some insulation for residential dwellings and cold and heat. This insulation can be further improved by pre-installing or retro fitting a range of commodity or proprietary systems.

The installation provided by plywood flooring is different in winter (heat flow out) to summer (heat flow in). Other significant factors effecting the “R”-values (a rating system for total thermal resistance of a building element) include floor height above ground, soil type, the relative humidity zone (as defined by the BCA), whether the site is sheltered or exposed, and whether the sub floor is opened, partly or fully enclosed.

For more details on R-values please refer to the FWPRDC (<http://www.fwpa.org.com>) Project No. PR05.1014 report “Insulation Solutions to Enhance the Thermal Resistance of Suspended Timber Floor Systems in Australia”.



The following table provides a guide to the range of some of the possible R-values for plywood flooring. Such situations such as sheltered sites, low set rather than elevated buildings and clay soil rather than sandy soil will increase the calculated R-value for a particular residence.

**Table of Indicative R-values for Plywood Flooring Systems**

Season	Winter (heat flow out)		Summer (heat flow in)	
	Open	Closed	Open	Closed
Plywood on joists	0.7 – 0.9	0.9 – 1.8	0.5 – 0.6	0.7 – 1.6
Plywood + U/L + carpet	1.0 – 1.2	1.2 – 2.1	0.8 – 0.9	1.0 – 1.9
Plywood + tiles	0.7 – 0.9	0.9 – 1.8	0.5 – 0.6	0.7 – 1.6
Plywood + ply ceiling under joists	1.1 – 1.2	1.3 – 2.2	0.7 – 0.8	0.9 – 1.8
Plywood + R2 bats between joists	3.0 – 3.2	2.9 – 3.7	2.5 – 2.8	2.7 – 3.5
Plywood + RFL over joists	1.6 – 1.7	1.8 – 2.4	0.8 – 0.9	1.0 – 1.6
Plywood + RFL under joists	1.7 – 1.8	1.9 – 2.5	0.8 – 0.9	1.0 – 1.6
Plywood + Concertina foil between	3.3 – 3.5	2.4 – 3.1	1.3 – 1.3	1.1 – 1.7
Plywood + Air-cell over bearers	1.8 – 1.9	2.0 – 2.6	0.9 – 1.0	1.1 – 1.7
Plywood + 50mm polyurethane spray under plywood	2.7 – 2.8	2.9 – 3.6	2.5 – 2.6	2.7 – 3.3

**Notes:**

1. U/L is carpet underlay
2. RFL is used under R2 batts with enclosed sub-floors
3. Wire mesh is used under R2 batts with enclosed sub-floors
4. With higher than R2 bulk insulation adding the increase in R-value to the above R2 value will be indicative
5. RFL is reflective aluminium foils
6. Air-cell is polyethylene & air between aluminium foils

**Fixings**

T&G structural plywood may be fixed to the sub-floor with hand or power driven fasteners, or a combination of mechanical fasteners and structural elastomeric adhesive for a more rigid squeak free system. Table two specifies the recommended fasteners, while the adhesive installation method is covered in the section on wet area flooring.

**Table 2: Minimum Fastener Specifications**

Hand driven nails	2.8mm min. dia. Flathead or bullet head nails of length at least 2.5 times plywood thickness
Gun driven nails	2.5mm min. dia. Gun nails of length at least 2.5 times the plywood thickness
Screws to timber joists	No. 8 x 30 self drilling countersunk wood screws
Screws to steel joists	No. 10 x 40 countersunk self drilling timber to metal screws

**Notes :**

1. If elastomeric glue is used in other than wet areas, the fastener spacing shown in Diagram 1 may be doubled.
2. Structural elastomeric adhesive or deformed shank nails shall be used where plywood is fixed to unreasoned floor joists of depth greater than 150mm.
3. Deformed shank nails shall be used where resilient floor coverings are to be fixed directly to the plywood.
4. Plywood can be fixed with 10-12mm of its edges.

## Floor Installation

The T&G structural plywood must be installed in accordance with the following recommendations:

1. The face grain of the panel and the tongue and grooved edges, must run parallel to span, i.e. perpendicular to the joists.
2. The end joints must be made on a structural sub-floor member, usually a joist.
3. Each panel must be continuous over more than one span.
4. If square edged structural plywood is used instead of T&G, the side edges must be fixed to a common nogging running between the joists, the nogging of timber being not less than 75mm x 30mm set flush to the top of the joist.

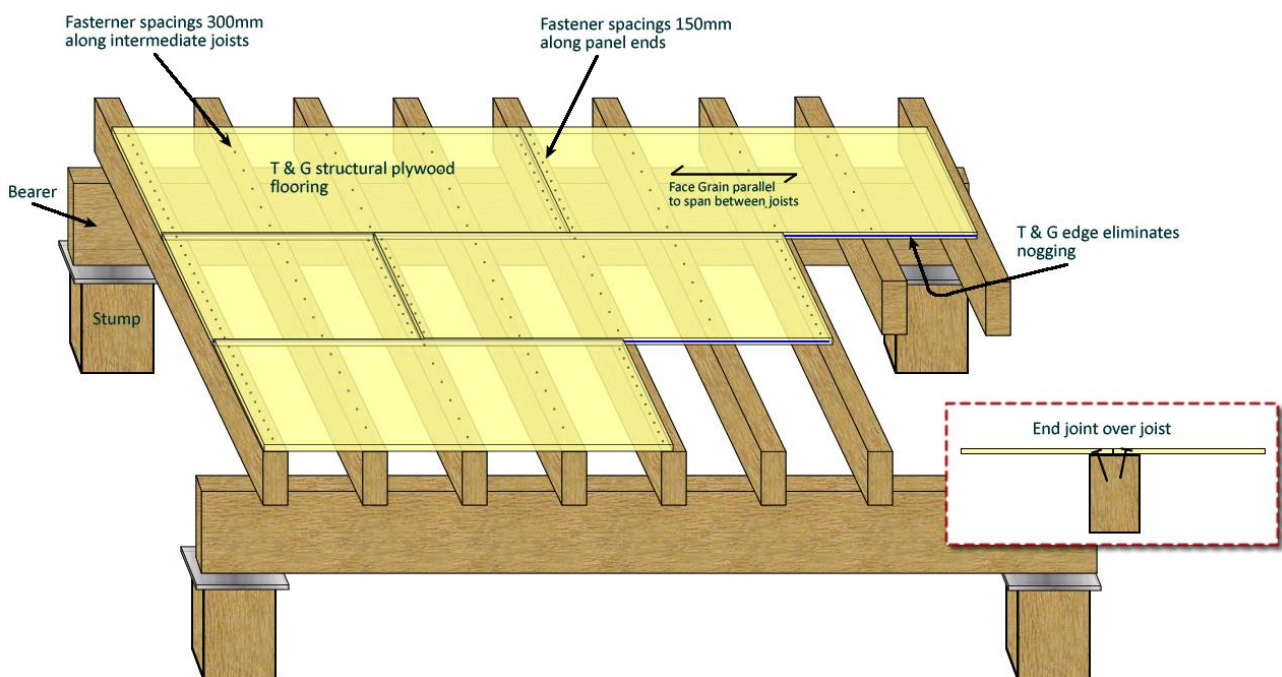


Diagram 1 : Installation of T&G Structural Plywood Flooring

### Notes :

1. The first row of panels should be laid to a string line to ensure edge straightness.
2. The face of the panel should be uppermost so the prepared face provides a smooth underlay. In standard T&G structural plywood to the brand stamp is usually on the back of the panel.
3. The end butt joints are staggered where possible in alternative rows to give a more rigid diaphragm.
4. Panels should be pushed together lightly by hand, **cramping is not recommended.**



## Sub-Floor Ventilation

It is critical that local government sub-floor ventilation requirements be adhered to strictly. Where proper sub-floor ventilation cannot be achieved, preservative treated plywood should be used.

## Finishing

A light sanding of the T&G structural plywood floor will usually be required prior to laying of floor materials. The objective of the sanding is to remove construction dirt and to smooth out any ridges where the plywood panels butt joint on joists. The sanding is very important where the plywood is to be used as the underlay for thin resilient floor covering such as vinyl. If the moisture content of the plywood has been stabilised after installation and it is in an environment of minimal change in humidity, the joints can be filled prior to laying thin resilient floor coverings. T&G structural plywood flooring normally requires no further underlays. It is designed to perform the dual functions of a structural floor and underlayment.

In residential buildings, 'standard' T&G plywood flooring is intended for use in floor covered by a wide range of floor coverings. Floors which may not require covering (eg. rumpus rooms) can be made serviceable by applying a timber floor finish. Interior wood stains may be applied to the plywood prior to the floor finish to create colour uniformity.

If a permanent 'decorative' plywood floor is required, plywood with a single species face of an appropriate quality may be specially ordered. Decorative T&G structural plywood flooring can be clear finished in exactly the same way as strip timber flooring.

## Wet Area Flooring

The additional requirements for the installation of T&G structural plywood in potentially wet area rooms, such as bathrooms or laundries are covered below. The objective of these additional requirements is to provide an impervious surface, and a floor system that can be suitably graded to a waste as required by local authorities in some states of Australia. This does not preclude the use of other systems that can be proven effective in providing an impervious surface over structural plywood.

The recommended system provides a means of bonding of the mortar bed to the plywood to form a composite and thus avoid the drumminess possible in other methods. Additionally, the system includes a flexible flashing over panel joints and floor to wall junctions to accommodate differential movement at such joints. **A shower tray must be used from the base of any shower recess.**

Requirements for wet area floors vary between states so local Authorities requirements should be checked. Australian Standard AS 3740-2004 "Waterproofing of Wet Areas within Residential Buildings" provides additional advice.

## Fixing

**In wet areas the T&G structural plywood must be glued with a structural elastomeric adhesive in addition to nail or screw fixing to the sub-floor.** The adhesive should be applied to either metal or timber joists in a 6mm bead. Apply two beads to joists where panels butt together. The panels should be placed in position within 10 minutes of applying the adhesive. Fastener spacings shall be 150mm along panel ends and 300mm centres along immediate joists. The fastener types and dimensions are as given previously in Table 2. The panels should be fully fixed within 15 minutes of placement.

**A further additional requirement over standard residential floors is that a bead of structural adhesive is applied to the tongue in the tongue and groove joint.**

## Approved materials

The approved elastomeric adhesives, flashing, epoxy adhesive and sealants at the time of writing are shown in Table 3:

**Table 3 : Approved Adhesives and Flashing**

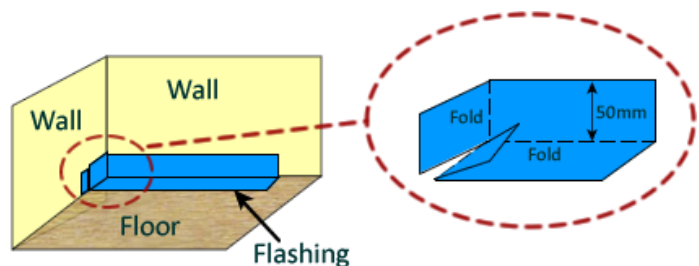
<b>Elastomeric Adhesives</b>	Norton's "Floormate" , H B Fullers 'Max Bond' or 'Sturdi Bond', or others that meet the American Plywood Association Standard AFG-01
<b>Flashing Tape</b>	Hypalon Flashing Strip produced by Trelleborg Queensland Rubber – available in 100mm wide rolls
<b>Epoxy Adhesive</b>	'HydrEpoxy 501' water based waterproof, two part epoxy adhesive
<b>Floor Sealant</b>	'HydrEpoxy 200' water based waterproof, two part epoxy interior sealer

\*this does not preclude the use of other proprietary systems meet the requirements of AS3740-2004

The flashing used shall be waterproof, tear resistant and flexible enough to absorb minor structural movement and suitable for use with the epoxy adhesive. The epoxy adhesive shall be non-sag, waterproof and flexible enough to absorb minor structural movement and shall firmly bond flashings to the surface of timber flooring, plywood flooring or approved wall linings.

## Floor to Wall Junctions

All floor/wall junctions must be flashed with an approved flashing firmly bonded to floor and wall framing or wall linings with an approved epoxy adhesive. Flashings should be returned up the wall at least 50mm. Where required the flashings can be cut to wrap around corners as shown in **Diagram 2**.



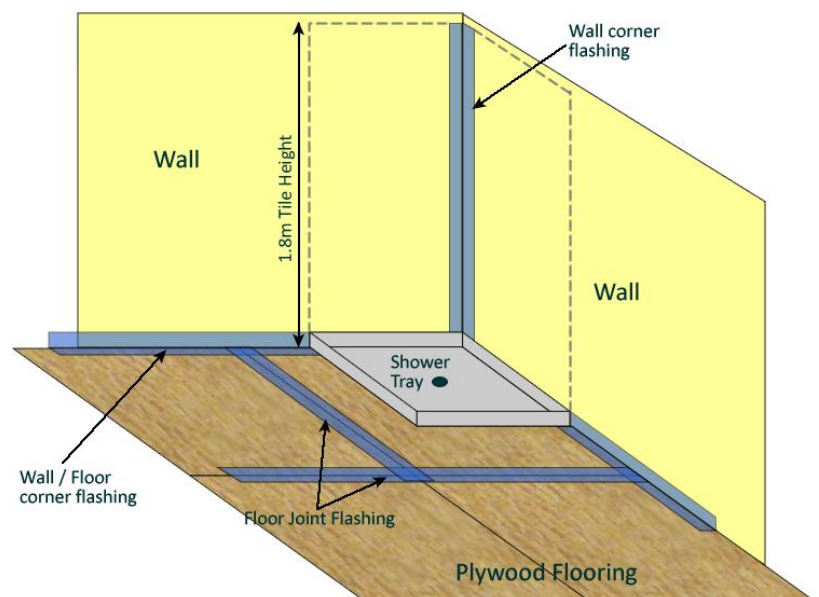
**Diagram 2 : Corner Flashing**

## Floor Joints

All flooring joints shall be flashed with approved flashing at least 100mm wide firmly bonded over flooring joints with an approved epoxy adhesive as seen in **Diagram 3**.

## Wall to Wall Junctions

Internal wall corner joints in shower recesses shall be fitted with flashing angle glue fixed to wall studs or wall linings with an approved epoxy adhesive from wall tile height to the bottom of the shower tray as shown in **Diagram 3**.



**Diagram 3 : Flashing Details for Shower Recess, Floor and Wet Wall joints in Wet Rooms.**

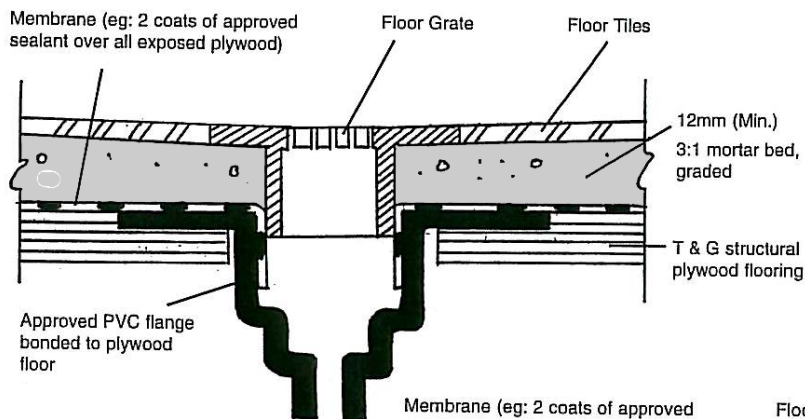
## Sealing the Plywood Floor Surface

Prior to the laying of the mortar bed and tiling, all of the exposed plywood flooring and flashing must be sealed with two coats of approved sealant mixed in accordance with manufacturers instructions. The first coat of sealant is diluted with water and usually applied by the builder or sub-contractor. This coat usually takes a minimum of two hours to dry.

The second undiluted coating of the same approved sealant is applied by the tiler as a waterproof bonding agent. The 3:1 mortar bed of minimum thickness 12mm is placed over the floor while this coating is tacky. Finally the tiles are fixed to the mortar bed which has been suitably graded to wastes.

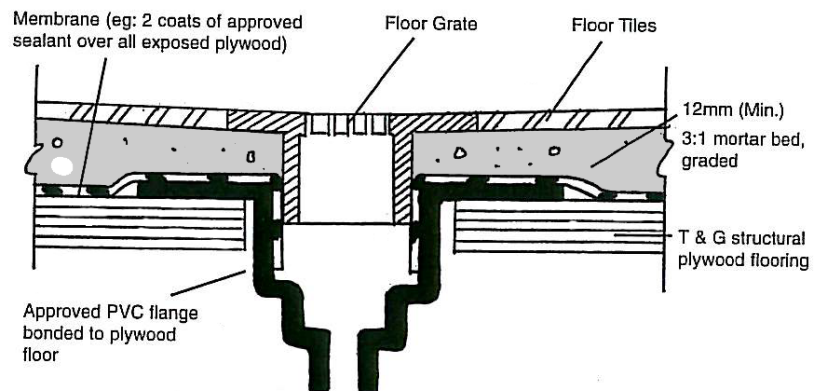
## Floor Waste and Shower Outlet

Floor wastes and shower outlets shall be installed in accordance with either the details of **diagram 4 or 5**. The floor grate must project at least 12mm above the floor surface to allow for adequate bedding of the floor tiles.



**Diagram 4 : Flashing Details for Recessed Floor Grates**

Note: Either Diagram is suitable for Plywood for "Wet Areas Flooring".



**Diagram 5 : Flashing Details for Non - Recessed Floor Grates**

## Revision History

Revision	Changes	Date	Who
3	<ul style="list-style-type: none"><li>• Minor grammatical / spelling changes</li></ul>	16-03-09	VR / MB
2	<ul style="list-style-type: none"><li>• Reformatted</li><li>• Cleaned up images.</li><li>• Clarified a point on imposed live loads in the "Installation" section.</li><li>• Modified note 4 of Table 1 to indicate that if the outer veneers are thicker, the values in the table are slightly conservative. This is in keeping with AS1684.2</li></ul>	09-03-09	MB
1	<ul style="list-style-type: none"><li>• Initial Release</li></ul>		

## EWPAA Members

Plywood and Laminated Veneer Lumber (LVL)				
Member Name	Location	Phone	Fax	Web
Ausply	NSW	+61 2 6926 7300	+61 2 6922 7824	<a href="http://www.ausply.com">www.ausply.com</a>
Austral Plywoods Pty Ltd	QLD	+61 7 3426 8600	+61 7 3848 0646	<a href="http://www.australply.com.au">www.australply.com.au</a>
Big River Group Pty Ltd	NSW	+61 2 6644 0900	+61 2 6643 3328	<a href="http://www.bigrivergroup.com.au">www.bigrivergroup.com.au</a>
Carter Holt Harvey Woodproducts Australia (Plywood) – Myrtleford	VIC	+61 3 5751 9201	+61 3 5751 9296	<a href="http://www.chhwoodproducts.com.au">www.chhwoodproducts.com.au</a>
Carter Holt Harvey Woodproducts Australia – Nangwarry LVL	SA	+61 8 8739 7011		<a href="http://www.chhwoodproducts.com.au">www.chhwoodproducts.com.au</a>
Carter Holt Harvey Woodproducts - Marsden Point LVL	NZ	+64 9 432 8800	+64 9 432 8830	<a href="http://www.chhfuturebuild.co.nz">www.chhfuturebuild.co.nz</a>
Carter Holt Harvey Woodproducts (Plywood) - Tokoroa	NZ	+64 7 885 5999	+64 7 885 5614	<a href="http://www.chhwoodproducts.co.nz">www.chhwoodproducts.co.nz</a>
Fiji Forest Industries	FIJI	+67 9 881 1088	+67 9 881 3088	
IPL (West Coast) Ltd	NZ	+64 3 762 6759	+64 3 762 6789	
Juken New Zealand Ltd (Gisborne)	NZ	+64 6 869 1100	+64 6 869 1130	<a href="http://www.jnl.co.nz">www.jnl.co.nz</a>
Juken New Zealand Ltd (Wairarapa)	NZ	+64 6 370 0650	+64 6 370 0653	<a href="http://www.jnl.co.nz">www.jnl.co.nz</a>
Nelson Pine Industries Ltd	NZ	+64 3 543 8800	+64 3 543 8890	<a href="http://www.nelsonpine.co.nz">www.nelsonpine.co.nz</a>
PNG Forest Products Ltd	PNG	+67 5 472 4944	+67 5 472 6017	<a href="http://www.pngfp.com">www.pngfp.com</a>
RH (PNG) Ltd	PNG	+67 5 325 5600	+67 5 325 6165	<a href="http://www.rhpng.com.pg">www.rhpng.com.pg</a>
Valebasoga Tropikboards Ltd	FIJI	+67 9 881 4286	+67 9 881 4154	
Wesbeam Pty Ltd	WA	+61 8 9306 0400	+61 8 9306 0444	<a href="http://www.wesbeam.com">www.wesbeam.com</a>

Particleboard and MDF				
Member Name	Location	Phone	Fax	Web
Alpine MDF Industries Pty Ltd	VIC	+61 3 5721 3522	+61 3 5721 3588	<a href="http://www.alpinemdf.com.au">www.alpinemdf.com.au</a>
Borg Panels Pty Ltd	NSW	+61 2 6339 6111	+61 2 6339 6220	<a href="http://www.borgs.com.au">www.borgs.com.au</a>
Carter Holt Harvey Woodproducts Australia	NSW	1800 891 881	+61 2 9468 5793	<a href="http://www.chhwoodproducts.com.au">www.chhwoodproducts.com.au</a>
D & R Henderson Pty Ltd	NSW	+61 2 4577 4033	+61 2 4577 4759	<a href="http://www.drhenderson.com.au">www.drhenderson.com.au</a>
Laminex	VIC	+ 61 3 9848 4811		<a href="http://www.thelaminexgroup.com.au">www.thelaminexgroup.com.au</a>
Tasmanian Wood Panels (Aust)	TAS	+61 3 9460 7766	+61 3 9460 7268	
Weatherex Pty Ltd	NSW	1800 040 080		<a href="http://www.weatherex.com.au">www.weatherex.com.au</a>



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 Visit [www.ewp.asn.au/register](http://www.ewp.asn.au/register) to ensure your products carry genuine EWPAA certification