Technical Data Sheet
Timber Floors Recommended Installation Practices 18

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Introduction

This data sheet outlines the recommended practices for laying timber strip floors over timber and engineered timber joists (it does not include steel joists), structural sub-floors such as plywood, particleboard and concrete. When laying a timber strip floors over joists, either directly on the joists or on sheet flooring fixed to joists, adequate sub-floor ventilation is essential for the satisfactory performance of the floor. Sub-floor ventilation recommendations are therefore included in this data sheet. The data sheet provides minimum fixing recommendations. Note that top nailing is a more robust fixing method than floors secretly fixed with adhesives. Top nailed floors can therefore accommodate greater movement. Increasing the amount of adhesive used will also provide a more robust fixing. Where greater floor expansion is expected after installation the method of fixing chosen and associated spacing of fixings or amount of adhesive used requires consideration.

Sub-floor Conditions

When the lower surface of timber floors or structural sub-floors (over which a timber floor is laid) are exposed to the ground and the space is enclosed (by brickwork etc), the sub-floor space must be adequately ventilated with permanent vents installed in the masonry during construction. The humidity in an enclosed sub-floor space can have a profound effect on the performance of a floor. If conditions are very moist, the lower surface of the boards may take up moisture, causing substantial swelling. Differential movement between the upper and lower surfaces of floor boards may also cause boards to cup. Similarly, caution needs to be exercised with timber floors laid in areas where the microclimate is often moist. In such locations the floor may reach higher moisture contents than in other nearby areas and additional allowance for expansion of the floor may be required (Refer Data Sheet 17 – Pre-installation Assessment). Timber floors should not be laid over moist sub-floor spaces, and structural sub-floors (e.g. plywood) cannot be relied upon to prevent moisture uptake in the T & G flooring if humidities in the sub-floor space remain high for extended periods. Sub-floor ground levels need to be graded and drainage provided so that in the event that any water should enter the sub-floor space, it can drain freely from it.

T & G floors should be provided with sub-floor ventilation that exceeds minimum BCA requirements. The levels outlined in the BCA (currently limited to 6000 mm² per metre length of floor for higher humidity areas) are primarily to limit the moisture content of sub-floor framing timbers, which can generally tolerate greater fluctuations in moisture content, than timber floors. The recommended minimum ventilation for T&G timber floors is 7500 mm² per metre length of wall, with vents evenly spaced to ensure that cross ventilation is provided to all sub-floor areas (refer Figure 1). In some localities, to meet constraints associated with energy efficiency, it may be decided to reduce ventilation levels to the values provided in the BCA. The BCA also outlines that a moisture barrier over the soil beneath the building reduces ventilation requirements and this approach is equally applicable to timber floors. If ventilation below the recommended level is used, due consideration should be given to alternative measures as outlined above and particular attention should be paid to ensuring that the sub-floor space remains dry throughout all seasons. The type of vent may also need to be considered with buildings in bushfire areas which limits the mesh size used in vents.

If there are doubts over the sub-floor humidity (areas of high water table, reduced airflow due to minimum clearances between the sub-floor framing and ground, external structures etc.) a polyethylene membrane may be laid over the soil (taped at joints and fixed to stumps and walls). This can significantly reduce moisture uptake by the sub-floor air. Increased levels of ventilation should also be considered in such instances. With dwellings on sloping blocks that have enclosed sub-floor spaces, the possibility of seepage should be taken into consideration and appropriate control measures taken prior to the installation of the floor.

The drainage system provided to the dwelling site, should ensure that run-off water will drain away from the building perimeter (not towards it) and that run-off water is prevented from entering the sub-floor space. The ground beneath a suspended floor should also be graded so that no ponding is possible. Where springs or aquifers are present (e.g. exposed by earthworks on sloping sites) and cause water to enter the sub-floor

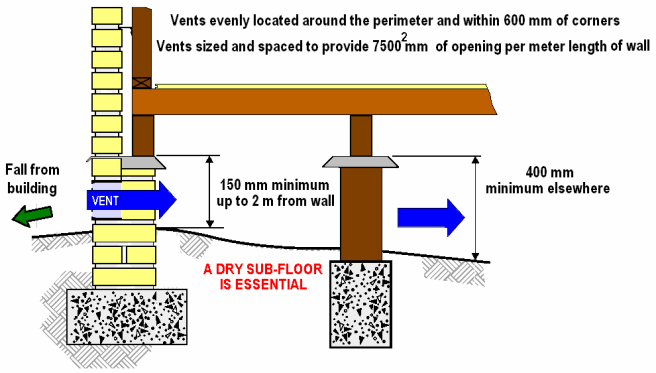

Figure 1 - Sub-floor Ventilation

Sub-floor Plywood and Battens

Plywood sub-floor material and battens need to be at a moisture content within a few percent of the flooring at the time of installation.

Moisture Content and Movement

Installation of Strip Flooring Over Joists

At the time of installation the moisture content of strip flooring used along coastal Queensland should be between 10% and 15%. The average should preferably be between 11% and 13%.

Construction Method

Where the timber floor is to be sanded and polished (i.e. feature floor) then fitted floor construction needs to be used. With this method, the timber flooring is installed after the roof cladding and external wall cladding are in place and the house is weather tight. This prevents initial degrade due to water and sunlight exposure and reduces damage from trades during construction.

Sub-floor Framing - Bearer size, floor joist size and flooring spans

The size of timber members used to support the flooring boards can be determined from AS 1684 - Residential timber-framed construction. For end-matched flooring profiles, joists with a minimum thickness of 35 mm may be used. Where plain end flooring is butt joined at floor joists, 45 mm or 50 mm thick joists are recommended to reduce splitting problems at butt ends.

If installing a secretly nailed floor over joists, seasoned timber or Cypress need to be used as secret nailing cannot be re-punched. If the joists shrink away from the floor, movement of boards on the fixings is likely to cause excessive squeaking.

Top (face) nailed floors may be fixed into either seasoned or unseasoned joists. If fixed into unseasoned joists they need to be of a species not exhibiting high rates of shrinkage and be in single or similar species. Species exhibiting high tangential shrinkage rates or prone to collapse or distortion should not be used unless seasoned. The potential effects of floor frame shrinkage require assessment prior to specifying or ordering unseasoned floor framing, and due allowance made in the building design and detailing. Similarly, after installation, the effects of both shrinkage and possible nail popping need consideration.

The allowable span of timber flooring is dependent on the timber species, density, grade, thickness and whether or not the flooring is end matched. Table 1 gives the acceptable joist spacing and maximum spans for various flooring products when fixed to timber joists. Maximum board span (the distance between where the timber is supported) needs to be considered in installations where flooring is at an angle to the joists, as this increases the board spans.

Laying

The moisture content, size and profile of the flooring should be checked (refer to Data Sheet 17 – Pre-installation assessment) prior to laying. If it is identified that the moisture content is not correct or the boards do not fit together properly, or are otherwise considered to not meet the specified grade, the installer should contact the supplier to resolve these issues before commencing laying. Similarly, any board found during laying that is considered outside the grade specification should not be laid.

In most instances boards are to be supported on at least three joists, however, there will be instances where some boards may not be (i.e. floor edges or the occasional shorter board within the floor), but this should be kept to a minimum. Flooring should be laid in straight and parallel lines. Butt joined boards must be cut to join over floor joists and joints in adjacent boards should be staggered. End-matched joints in adjacent boards should not occur within the same span between joists. It is essential that boards are in contact with the joists at the time of nailing, particularly when machine nailing is used, as this type of nailing cannot be relied on to pull the board down to the joist.

It is generally recommended that not more than 800 mm of flooring is cramped at any one time, however, this may be varied by the installer depending on the flooring used and conditions in which the floor is laid. The pressure used to cramp the boards together will differ from one floor to another, depending on the moisture content of the flooring at installation, the air humidity and the average moisture content conditions for the location. As a general rule, cramping should be sufficient to just bring the edges of adjoining boards together while maintaining a straight line.

Allowance for expansion in floors

Fitted floors require a minimum 10 mm expansion gap between the floor boards and any internal or external wall structures. However, where board ends abut doorways the gap may be reduced to a neat fit but with a small gap (approximately 1 mm) to prevent rubbing. Floors up to 6 m (measured at right angles to the run of boards) should not require intermediate expansion joints provided that normal atmospheric conditions exist. For floor widths over 6 m or where extra allowance for expansion is required (e.g. moist locations) cramping pressure needs to be considered along with providing an intermediate expansion joint, or a series of smaller expansion gaps every 800 mm to 1000 mm to provide equivalent spacing. If cork expansion joints are used, the cork should be 2 mm or so proud of the floor surface when installed. This will be removed during the sanding process. However, cork to the perimeter should be installed level with the timber surface. Refer to Figure 2 for details of expansion gaps.

Species Group	Grade	Thickness (mm)	Acceptable Species, Grade and Joist Spacing			Maximum Span	
			450 mm End matched	450 mm Butt joined	600 mm Butt joined	End matched	Butt joined
Hardwood	AS 2796						
All hardwood species listed in Datasheet 1	Select Grade	19	✓	✓	✓	500 mm	630 mm
	Medium Feature (Standard) & High Feature Grade	19	✓	✓	✗	450 mm	570 mm
Cypress	AS 1810						
	No. 1	19	✓	✓	✗	410 mm	510 mm
	No. 2	20	✓	✓	✗	410 mm	510 mm
Softwood	AS 4785						
Slash Pine	Select & Standard Grades	19	✓	✓	✗	410 mm	510 mm
Other pinus species	Select & Standard Grades	19	✗	✓	✗	350 mm	470 mm
Araucaria (Hoop Pine)	Manufacturers Grades	20	✓	✓	✗	410 mm	510 mm

Table 1 - Allowable Joist Spacing and Maximum Span of Floorboards

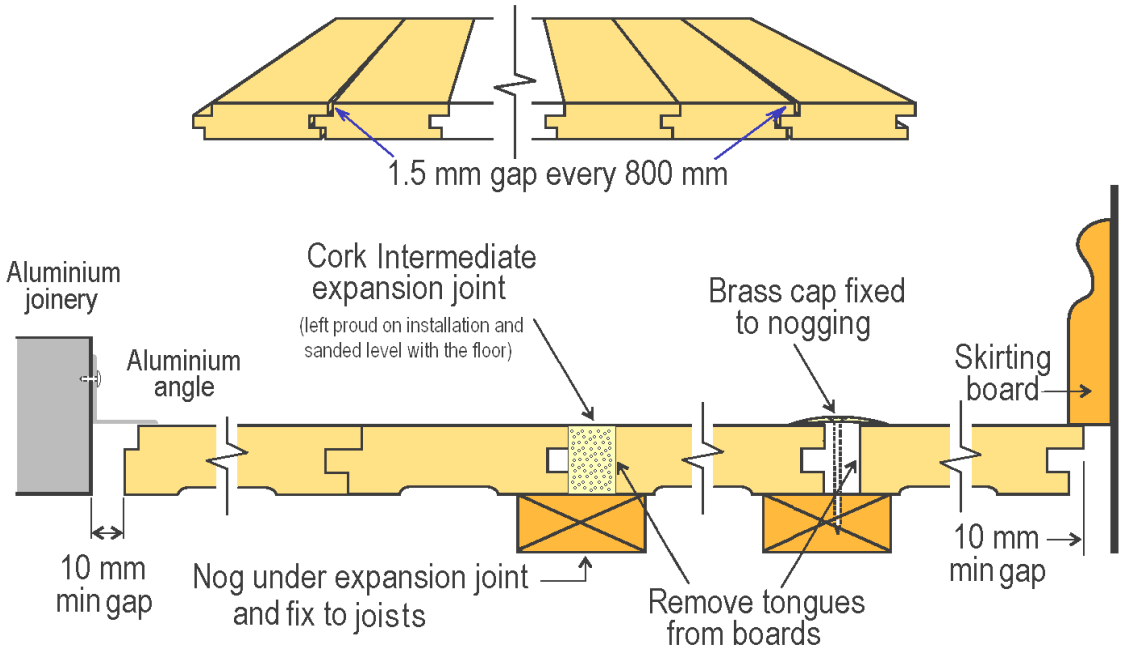

Figure 2 - Expansion Gap details

Fixing of floors

Boards with cover widths of 65 mm or less should be top (face) nailed with one or two nails at each joist. Boards with cover widths over 65 mm should be top (face) nailed with two nails at each joist. Secret fixing with a single nail or staple per joist is suitable with secret nail profile end-matched boards having nominal cover widths not greater than 85 mm. The recommended minimum fixing sizes are shown in Table 2. The recommended minimum edge distance for nailing at butt joints or board ends is 12 mm. All nails, including machine nails, should be punched a minimum of 3 mm below the top surface.

During fixing, the joint between floor boards and the top surface of floor joists should be checked to ensure that gaps are not present. If gaps are present, nails should be punched to draw boards tightly onto joists.

Installation of Strip Flooring Over Existing Timber and Sheet Floors on Joists

Assessing the Existing Floor

Timber T & G flooring may be laid over existing T & G or sheet floors (plywood or particleboard). Where the existing floor is structurally sound, either overlay flooring (generally 11 mm to 14 mm thick) or structural flooring (generally 19 mm to 21 mm thick) can be laid. Floors may be fixed into the joists or with shorter fixings at reduced centres into the existing floor only. In instances where there is doubt over the structural adequacy of the existing floor, defective boards or sheets should be replaced to make the existing floor structurally sound, or structural flooring fixed through to the joists can be used. To provide a level surface, top (face) nails in existing flooring should be re-punched and the existing floor rough sanded. Adhesives require a clean, structurally sound floor that is free from moisture, loose particles and contaminants. It is also particularly important that if a new floor is laid at 90˚ to an existing floor, the existing floor must be structurally sound and level. In some instances sheet

TYPE OF FIXING	FLOOR JOIST TIMBER	
Top (Face) Fixing	SOFTWOOD, LVL and I - BEAMS	HARDWOOD & CYPRESS
Without Adhesive		
Hand driven	65 x 2.8 mm bullet head	50 x 2.8 mm bullet head
Machine driven	65 x 2.5 mm T-head	50 x 2.5 mm T - head
With Adhesive #		
Hand driven	50 x 2.8 mm bullet head	
Machine driven	50 x 2.5 mm T - head	
Secret Fixing		
With Adhesive #		
Machine driven	50 x 15 gauge staple	45 x 15 gauge staple

A continuous bead (6 mm approx.) of polyurethane flooring adhesive to be applied to the joist

Table 2 - Minimum Fixing of T&G Flooring to Joists

sub-floors (substrates) can sag between joists and if not leveled the sagging will show through to the new floor.

It is also necessary to check that the existing floor moisture content is appropriate to accept the new floor. The cause of any excess moisture (wetting during construction, leaks, inadequate sub-floor ventilation, etc) needs to be addressed prior to installation. Moisture meters are unpredictable in sheet flooring and this may necessitate oven dry testing. Prior to laying, the existing floor should be of similar moisture content (within a few per cent) to the new floor.

Squeaking present in an existing T & G floor may be reduced by providing a bead of polyurethane flooring adhesive to fill any gaps between the underside of flooring and tops of joists (caused by cupping, shrinkage etc). Further reductions may be achieved by fixing a seasoned batten (approximate dimensions 35 x 45 mm), to the underside of flooring (mid-span between joists) fixed with a full length bead of polyurethane flooring adhesive and screwed at approximately 300 mm centres.

Installation

Installation of flooring should not be done until other construction activities (particularly wet trades) are complete and after the building is roofed and enclosed, with the temperature and humidity as close as possible to the expected in-service conditions. Expansion gaps of 10 mm should be provided at all walls and other fixed obstructions, which are parallel to the run of floor boards. Intermediate expansion joints should also be provided in larger floors (width at right angles to boards exceeding 6 metres), to give an equivalent gap of 10 mm every 6 metres (approx. 1.5 mm every 800 mm).

Fixing flooring through sheet floors and into the floor joists will provide a more robust fixing and is particularly appropriate where greater expansion in the floor is expected after installation. Alternatively, if expansion after installation is expected to be small then mechanical and adhesive fixing into the sub-floor (substrate) may be used.

For secret fixing of structural flooring boards, secret nail profile boards should be used (maximum cover width of 85 mm) with one fixing per board at the appropriate spacing. For (top) face nailing, standard profile or secret nail profile boards may be used. Boards exceeding 65 mm cover width, which are top (face) nailed, require two nails per board at each fixing.

Secret Fixing into Sub-floor (Substrate) Only

When relying on the sub-floor or substrate for fixing, boards should be secretly fixed with the first and last few boards that do not allow secret fixing, top (face) nailed and adhesively fixed with polyurethane flooring adhesive. When laying over an existing T&G sub-floor the new flooring may be laid either parallel to it (with boards offset half a board width) or with boards at 90° to the existing floor, providing the sub-floor (substrate) is level. If edge bonding is present in an existing T&G floor over which the new floor is being laid, it is recommended that the bonding is relieved by a series of saw cuts down the length of the existing boards and that the new floor is laid at 90°. Fixings should be the maximum possible length as indicated in Table 3.

When staple fixing at close centres is being used, provide a cushion of polyurethane flooring adhesive between the two floors to minimise possible squeaks. This is achieved by using a continuous bead of adhesive at 90° to board length, midway between fixing points. Where polyurethane flooring adhesive is used to provide much of the fixing, staples may be spaced up to 450 mm apart. Note that flooring cleats (as used with Powernailer) of a similar length may be used in lieu of staples.

Top (Face) Nailing into Joists through the Sub-floor (Substrate)

If the sub-floor is an existing T&G floor, boards should be run in the same direction as the sub-floor with boards offset by half a board width from those in the existing floor. This assists in offsetting the nails in the new and old floors. When structural 19 mm flooring is used, the floor should be top (face) nailed with 65 x 2.5 mm machine nails or 65 mm x 2.8 mm hand nails through the existing floor and into the joists. For thinner overlay flooring, 50 mm x 2.5 mm machine nails or 50 mm x 2.8 hand nails should be used. In all cases, continuous beads of polyurethane flooring adhesive should be provided at the joists and midway between them to provide a cushioning effect between the two floors. Board ends adjacent to walls should be fixed with polyurethane flooring adhesive and nailed to the sub-floor.

Installation of Strip Flooring Over Concrete

Assessing the Concrete Slab

Timber floors may be laid on battens or plywood over a concrete slab, or by direct fix. Direct fix to the slab is a specialist field and appropriate professionals in this field should be consulted if considering this method. This data sheet covers installation of T & G flooring on plywood over concrete or battens over concrete. Prior to installation it is necessary to ensure that the concrete is sufficiently level to accept the system. Where the slab is greater than ± 3 mm out of level over any 1500 mm length, a concrete topping (leveling compound), grinding or packing should be used. Slabs on ground should be constructed with a continuous under slab vapour barrier (e.g. 0.2 mm thick polyethylene). Timber floors should not be installed until the concrete slab has a moisture content less than 5½% (generally achieved after slabs have cured for approximately 4-6 months). In old slabs, moisture contents should be below this level and if not, care should be exercised. Various methods are available to test the moisture content of concrete, including resistance meters, capacitance meters and hygrometers.

FIXING METHOD	SECRET FIXING TO SUB-FLOOR (SUBSTRATE) ONLY
Staple fixing up to 250 mm spacing	Staples - 32 x 15 gauge to plywood or 38 x 15 gauge to particleboard for flooring 19 to 21 mm thick. Zigzag pattern of polyurethane flooring adhesive between fixing points. (For overlay flooring maximum length to suit sub-floor (substrate)).
Adhesive fixing with staples up to 450 mm spacing	Polyurethane flooring adhesive - zigzag pattern to achieve approx. 25% glue contact area after laying. Staples - 32 x 15 gauge to plywood or 38 x 15 gauge to particleboard for flooring 19 to 21 mm thick. (For overlay flooring maximum length to suit sub-floor (substrate)).

Table 3 - Minimum Secret Fixings of T&G Flooring to Plywood Sub-floor (Substrate) over a Slab

Installation

When floors are to be fixed over a plywood sub-floor, overlay or structural flooring may be used. For fixing to battens, structural flooring (19 mm or thicker) should be used. The plywood sub-floor or battens need to be at a moisture content within a few per cent of the flooring at the time of installation.

Installation of flooring should not occur until other construction activities, particularly wet trades, are complete. The building should be roofed and enclosed with the temperature and humidity as close as possible to the expected in-service conditions including the use of air-conditioning if applicable. For secret fixing, secret nail profile boards should be used (maximum cover width of 85 mm) with one nail per board at each fixing. For top (face) nailing, standard profile or secret nail profile boards may be used. Boards exceeding 65 mm cover width require two nails per board at each fixing. Expansion gaps of 10 mm should be provided at all walls and other fixed obstructions, which are parallel to the run of floor boards. Intermediate expansion joints should also be provided in larger floors (width at right angles to boards exceeding 6 metres), to give an equivalent gap of 10 mm every 6 metres (approx. 1.5 mm every metre 800 mm) or the use of loose cramping.

As an added protection against moisture from the slab (from slab edge effects, beam thickening etc) or minor building leaks, a 0.2 mm thick polyethylene or poured chemical membrane over the slab is recommended. The polyethylene should be lapped by 200 mm, taped at the joints and brought up the walls (or fixed columns etc) above the top of the flooring. The polyethylene is then covered by the skirting. Note that fixings of plywood sub-floors or battens through the polyethylene is not considered to reduce the overall effectiveness of the membrane.

Fixing recommendations - plywood sub-floors to concrete slabs and flooring to plywood

Plywood sub-floors should be structural grade, a minimum 15 mm thick and with a type A bond. Sheets may be installed in a 'brick' pattern or 45° to the direction of the strip flooring with a 6 mm gap between sheets and a 10 mm gap to internal and external walls. Various methods of fixing are used including adhesives and mechanical fixing. The option detailed below is for hand-driven spikes which provides solid fixing to the slab:-

- Slabs should be level to ± 3 mm in 1.5 m. If not, the effect needs to be assessed and as appropriate the use of a topping compound prescribed for the purpose or other measures to provide a satisfactory floor installation should be undertaken.
- Install 0.2 mm polyethylene vapour barrier
- Fix plywood sheets to the slab with hand driven 50 mm long by 6.5 mm spikes ('Powers SPIKE' or equivalent). A minimum of 20 spikes to be used per 2400 mm x 1200 mm sheet, equally spaced and with the outer spikes 75 mm to 100 mm from the sheet edge. If a brick pattern is used, it is preferable that sheets be staggered by 900 mm so that fixings do not line up from sheet to sheet.

Fixing recommendations are provided in Table 4 and Figure 3. When staple fixing at close centres is being used, provide a cushion of polyurethane flooring adhesive between the two floors to minimise possible squeaks. This is achieved by using continuous bead of adhesive at 90° to board length, midway between fixing points. Where polyurethane flooring adhesive is used to provide much of the fixing, staples may be spaced up to 450 mm apart. Note that flooring cleats (as used with *Powernailer*) of a similar length may be used in lieu of staples.

FIXING METHOD	SECRET FIXING TO SUB-FLOOR (SUBSTRATE) ONLY
Staple fixing up to 250 mm spacing	Staples - 32 x 15 gauge to plywood for flooring 19 to 21 mm thick. Zigzag pattern of polyurethane flooring adhesive between fixing points. (For overlay flooring maximum length to suit sub-floor (substrate)).
Adhesive fixing with staples up to 450 mm spacing	Polyurethane flooring adhesive - zigzag pattern to achieve approx. 25% glue contact area after laying. Staples - 32 x 15 gauge to plywood sub-floor (substrate) for flooring 19 to 21 mm thick. (For overlay flooring maximum length to suit sub-floor (substrate)).

Table 4 - Minimum Secret Fixings of T&G Flooring to Plywood Sub-floor (Substrate) over a Slab

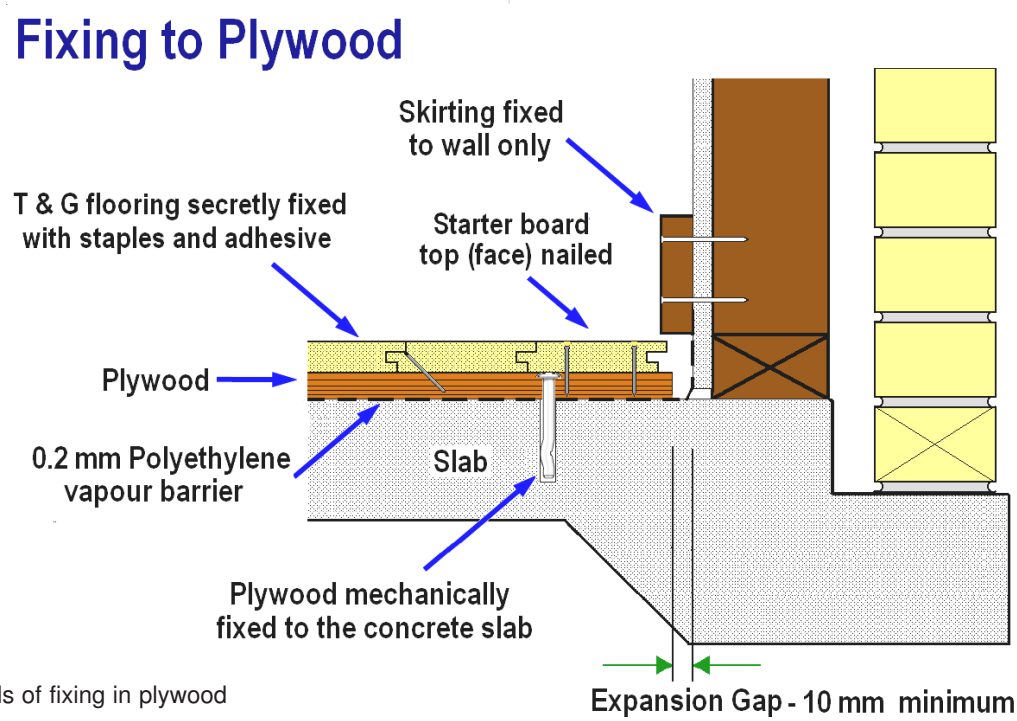

Figure 3 - Details of fixing in plywood

Fixing recommendations - battens to concrete slabs and flooring to battens

Battens are to be seasoned and may be either hardwood or softwood. Battens may be fixed to the slab using 75 mm gun nails at 600 mm maximum spacing, 6.5 mm dia. 'Powers Spike Fasteners' with a minimum embedment of 32 mm or equivalent at 900 maximum spacing or M6 masonry anchors at 900 mm maximum spacing. Table 5 outlines the minimum batten size and fixing requirements for structural flooring to battens. Batten spacing is dependent on the species and grade of flooring used. It shall be the same as for flooring over joists as provided above in Table 1. Figure 4 outlines details of fixings into battens. When 19 mm thick hardwood battens are used, additional adhesive is necessary to compensate for the reduction in staple length.

TYPE OF FIXING	BATTEN TIMBER & SIZE		
Top (Face) Fixing	HARDWOOD & CYPRESS 35 X 70 mm	HARDWOOD 19 x 80 mm	SOFTWOOD 35 X 70 mm
Without Adhesive			
Hand driven	50 x 2.8 mm bullet head	–	50 x 2.8 mm bullet head
Machine driven	50 x 2.5 mm T - head		50 x 2.5 mm T - head
Secret Fixing			
With Adhesive #			
Machine driven	50 x 15 gauge staple	32 x 15 gauge staple	50 x 15 gauge staple

A continuous bead (6 mm approx.) of polyurethane flooring adhesive to be applied to 35 x 70 mm battens and the equivalent of 2 beads to 19 x 80 mm hardwood battens

Table 5 - Minimum Fixing T&G Flooring to Battens over a Slab

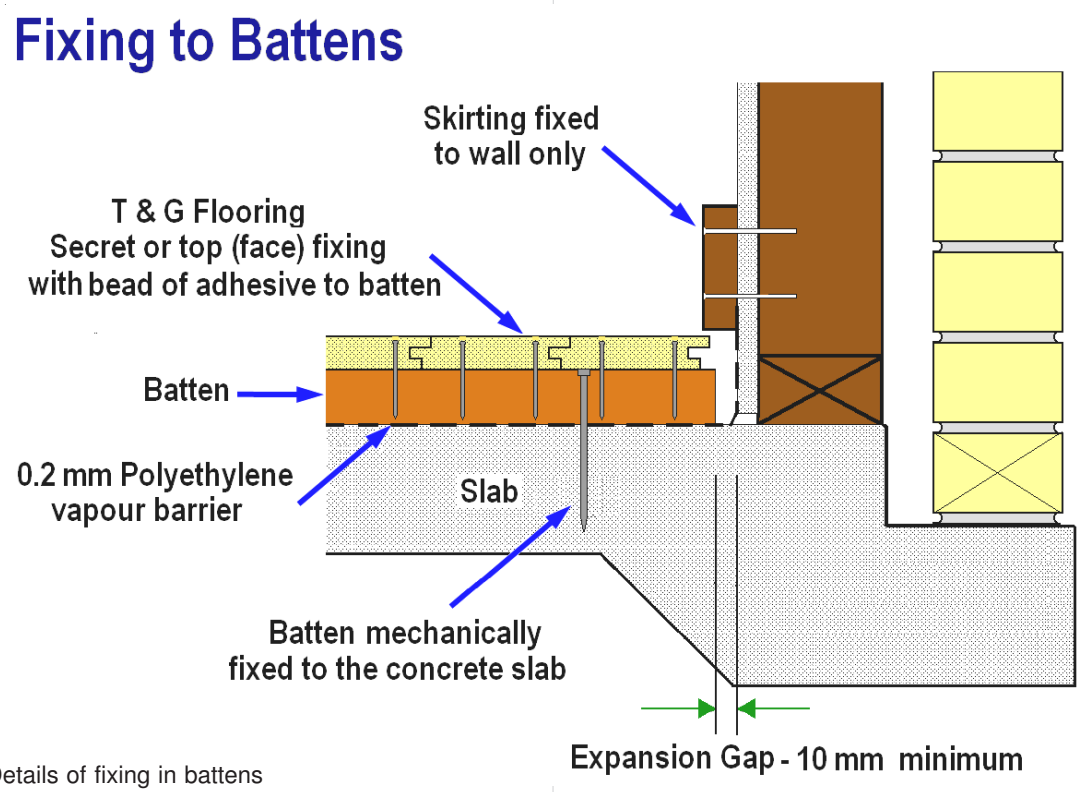

Figure 4 - Details of fixing in battens

Safe Working

Working with timber produces dust particles. Protection of the eyes, nose and mouth when sanding, sawing and planing is highly recommended. Refer to tool manufacturers for safe working recommendations for particular items of equipment.

Disposal of Offcuts and Waste

For any treated timber, do not burn offcuts or sawdust. Preservative treated offcuts and sawdust should be disposed of by approved local authority methods.

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