Timber Strip Floors
Fixing and Finishing

National Timber Development Council

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This is the First Edition of 'Timber Strip Floors - Fixing and Finishings' guide produced by the National Timber Development Council in association with the Forest and Wood Products Research and Development Corporation.

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NATIONAL TIMBER DEVELOPMENT COUNCIL

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INTRODUCTION

Scope

The focus of this document is to provide a reference guide for the installation of timber strip flooring over bearers and joists, timber sheet floors and concrete slabs. The scope includes site assessment and measurement, site delivery and storage, installation and finishing. Additional information on problem identification and rectification is also included. This information is based on the current “best practice” approach with input provided from a number of recognised organisations and individuals specialising in timber flooring.

Timber - The Material

Impact Of Moisture

Timber is a natural product, and responds to its surrounding environment. It is a hygroscopic material - that is, it changes its own moisture content to be in equilibrium with the atmosphere (EMC – Equilibrium Moisture Content). As this moisture is taken up or expelled, the physical dimensions of the material also changes. Most timber flooring products are kiln dried to a level of moisture content within a range of 8-14 % as specified in the Australian Standard 2796. Timber will either take up or shed moisture to be in equilibrium with the prevailing conditions. Moisture content (MC) refers to the percentage weight of water present in the timber compared to the weight of the timber with all the water removed (dry weight). Where timber is installed in conditions where the prevailing conditions are moist, either through the local climatic conditions or specific site conditions, the timber absorbs moisture and increases the dimensions of the board. Conversely, where prevailing conditions are drier than that of the timber in its delivered state, the timber will shrink.

In flooring, the movement is generally most apparent across the width of the board rather than the length. Over a floor area, the combined affects of board shrinkage or growth can be substantial if the change in MC is high. The wider the board the greater will be the potential for movement. Additionally, for some species their physical changes will be greater and potentially more rapid than for other species, in the same conditions. Softwoods generally absorb and expel moisture far more rapidly than hardwoods.

Movement in Timber Floors

Timber is a natural product and will absorb and loose moisture during its life. Consequently, strip flooring will always exhibit some movement between individual boards. During dry weather, small gaps may appear between individual boards. These gaps will tend to close up during periods of higher (air) moisture content. The selection of finishes can also impact upon the ability of the floor to make these movements evenly and without "edge" bonding of groups of boards producing unsightly randomly spread large gaps.

Localised movement of timber ie in a certain area of the house or room, can be caused by heat sources such as heaters, direct sunlight through windows and glazed doors, hot air released from electrical equipment or other sources of heat. Generally the exposure needs to be for relatively prolonged periods for this localised shrinkage to occur.

Air-conditioning may also impact upon the movement of boards depending on the frequency of use by reducing the air moisture/humidity levels in the room. With prolonged use, the boards will tend to acclimatise to the air-conditioned environment, which is generally drier than the prevailing conditions. The boards may subsequently shrink leaving gapping between boards. If the environment is to be continuously air-conditioned, boards must be acclimatised to these dry conditions, or specified appropriately.

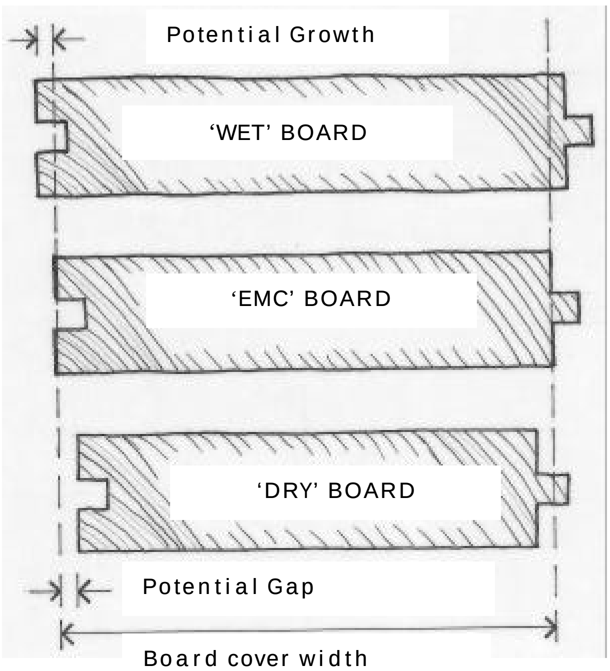


Fig 1 Wet Board Dry Board Movements

SECTION 1 SITE ASSESSMENT

1.1 Introduction

Many of the problems encountered by inexperienced floor practitioners can be related back to the critical area of site assessment. The pressures imposed by the builder to install the flooring at an unsuitable stage of the construction process i.e. inadequate sub-floor ventilation, subsoil conditions and potential complications imposed by heated slabs and air conditioning systems can all impact on the performance of the flooring. The practitioner must clearly understand the impact of the site conditions upon the long-term performance of the floor. With a strong knowledge of these issues, the various cause and effects can be relayed to the client to minimise any potential dispute.

Trade Sequencing

Timber floors should be installed only after a building has been fully weather proofed. The roof cladding is on, the windows and external doors are installed and the exterior cladding is completed. This is often termed as “Lock-up” stage where the outer shell of the building is completed and the internal fit out and finishing work is underway.

Wet Trades

Timber floors are often used as a convenient working platform by the various trades involved in the construction of the building. The problem with this approach is that many of these trades involve substantial volumes of water thus impacting on the environment of the building and hence the moisture content of the flooring. Trades such as cement rendering, which may be installed at this stage of the building works, increase the relative humidity of the building to very high levels. It is not uncommon to see condensation running down the inside of the windows as the warm moist air in the building contacts the glass cooled by the external environment. A timber floor in these conditions of high humidity would take up the moisture from the internal atmosphere and increase in size, potentially impacting on the structure of the building. Additionally, large amounts of render may fall onto the floor in the rendering process impacting more directly on localised areas of flooring with a high potential to deeply stain the board. Likewise with floor tiling particularly where the area is large and the tiles are set into a sand and cement bed. Large volumes of water is released into the building during the installation and curing period.

From these examples it can be clearly shown that the timber floor should not be installed prior to the completion of these wet trades.

1.2 Stormwater

Inadequate or incomplete stormwater systems can also In many cases the physical connection of the stormwater system to the street or retention storage is not finalised until very late in the construction process. This may potentially allow the stormwater to penetrate into the sub-floor area of the house raising the moisture content of the boards as a direct result. This condition though temporary in terms of being reflective of the prevailing conditions, has the potential effect of cycling boards through a series of wet to dry conditions. An additional problem is that the atmospheric conditions of the sub-floor area, as compared to the conditions within the building, vary markedly potentially leading to the cupping of boards.

The stormwater system must be complete or effectively directed away from the sub-floor area.

1.3 Sub-Floor Ventilation

The provision of adequate sub-floor ventilation is essential for the long-term performance of the floor. In many cases, the sub-floor ventilation requirements are also impacted by the adequacy of the site drainage with more ventilation required the damper the sub-floor conditions. Where conditions are damp and the potential for any additional sub-soil drainage is limited, the installation of an impervious plastic membrane over the ground in the sub-floor area reduces the moisture vapour permeating into the floor. The membrane joins should be lapped a minimum of 300mm and tape sealed with an up turn at the perimeter and internal walls and stumps/piers. Sealing around these is not critical however any care taken in sealing these areas will improve the overall effectiveness of the membrane. Care should be taken to avoid water ponding on top of the membrane. Any solid water draining onto the surface of the membrane will mitigate any effectiveness of the system. Where damp conditions prevail - the source needs to be identified and rectified.

The table detailed below covers the various requirements for sub-floor ventilation showing the actual effective area of opening for the various vent types commonly used. It is important to understand that sub-floor ventilation should flow - without having any “dead” pockets of air. Dwarf walls within the sub-floor area should have adequate openings so as not to restrict this flow of air. The ventilation openings must not be covered or restricted with objects either within the sub-floor or externally by gardens or other objects. This is a housekeeping issue, which should be pointed out to the occupants and/or builder.

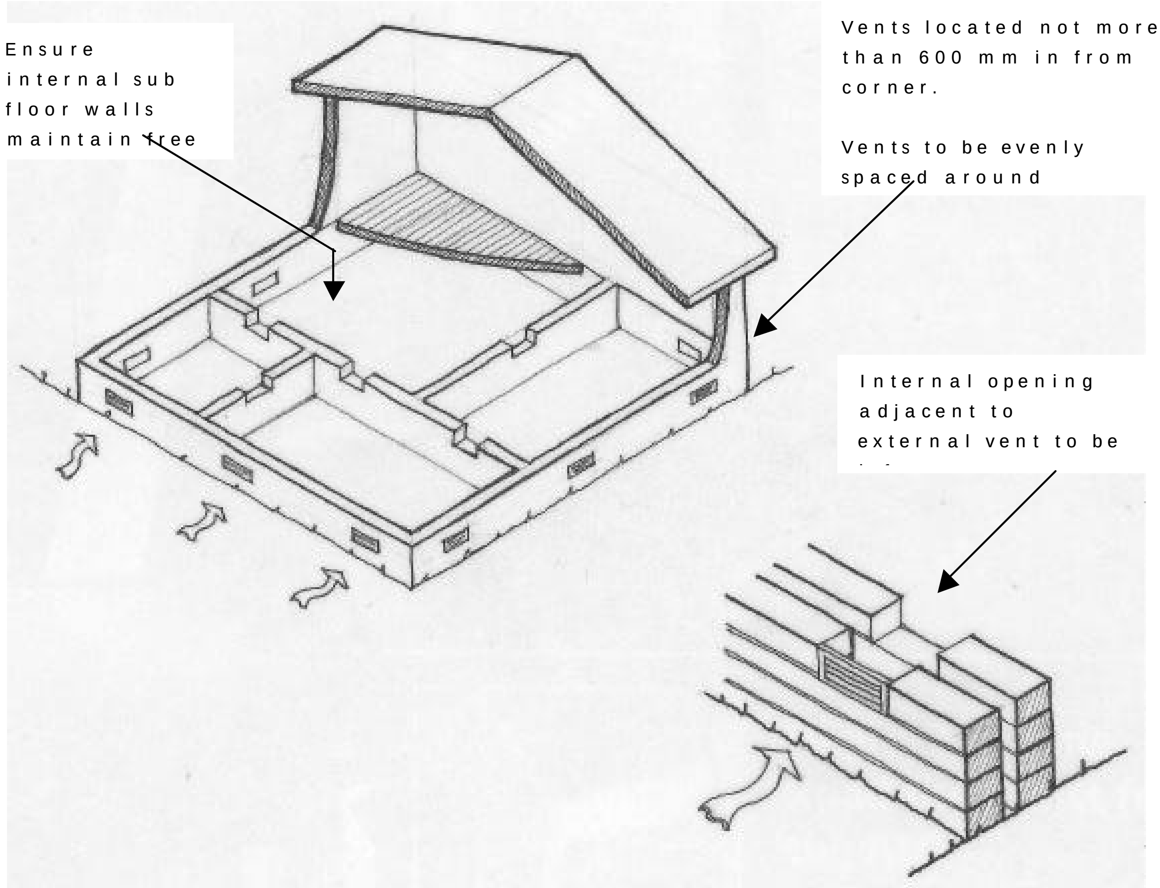
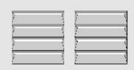
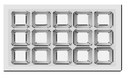
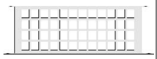
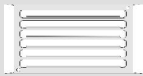


Fig 2 Sub-Floor Ventilation Flow

Table 1 Sub-Floor Ventilation and Clearance

Climate Zone (Refer Appendix A)	Minimum sub-floor ventilation (mm^2/m of wall)		Minimum height from ground surface (mm)	
	No membrane	Ground sealed with impervious membrane	Termite Inspection not required	Termite Inspection required (see note)
1	2000	1000	150	400
2	4000	2000	150	400
3	6000	3000	150	400
Note: On sloping sites, 400 mm clearance may be reduced to 150 mm within 2m of external walls.				

Table 2 Commercially Available Sub-Floor Vents

Vent Type and Specifications				Approx. Nett Ventilation Area Provided per Vent (mm^2)	Vent Spacing In Accordance with AS3660.1 (mm)	Number of Bricks/Blocks Between Vents
Material	**Diagram**	**Vent Size**	**Vent Pattern**			
Clay (standard off the shelf items		160 x 230	8 slots each 75mm x 8mm	4800	658	2
Clay (standard off the shelf items)		160 x 230	15 holes each 16mm x 16mm	3840	526	1.5
Metal (suit blockwork construction)		200 x 400	8 slots 10 slots each 100mm x 8mm	5900 7400	808 1014	1 1.5
Metal (suit blockwork construction)		200 x 400	8 slots 10 slots each 175mm x 8mm	10700 13360	1466 1830	2.5 3.5
Gradwell Cast Aluminium Air Vent		9" x 6" (230 x 160)	4 slots each 195mm x 10mm	7800	1068	3.5
Pryda Vent Pryda Vent		230 x 75 230 x 165	52 holes 117 holes each 11mm x 11mm	6292 14157	862 1939	2.5 7
Pryda Slim Vent (GVS90) Pryda Slim Vent (GVS90H)		250 X 90 130 X 90	12 slots 6 slots each 110mm x 8mm	10560 5280	1447 723	5 2

1.4 Concrete Slabs

The installation of timber flooring over concrete slabs is now a very common application given the high percentage of new houses built on concrete slabs. At the time of installation of the timber floor, the slab should be dry with a moisture content of no more than 5.5%. The concrete used for the slab initially contains a very high proportion of water, which is utilised in the hydration or curing process of the concrete. The curing process subsequently generates heat and water vapour. The actual drying time for the slab is dependent on a number of factors including; the thickness of the slab, slab thickenings ie internal beams, drop edge beams etc, climatic conditions, curing process ie sealed surface finishes and treatment during construction ie wetting caused by trades.

Given the above it is reasonable to suggest that an approximation of drying time would not be an accurate method of ascertaining the suitability of the slab for a timber floor. One such approximation method was that a time of one month per 25mm thickness of slab for drying time plus one month is required. This does not take into account any thickenings, slab treatments or sealing compounds and cannot be relied upon as a stand-alone assessment. There are a number of methods available to test the slab's moisture content and these are detailed in Appendix B.

An additional source of moisture within the slab, which can vary, is the adequacy of the vapour barrier. The vapour barrier, typically a polyethylene sheet of 0.2mm minimum thickness is placed on the prepared slab base before the reinforcement or concrete is placed. The barrier is designed to protect the slab against moisture vapour rising through the subsoil and condensing in the slab or being trapped under impermeable floor coverings. The vapour barrier is not a barrier against free water, which is best dealt with by effective site drainage, adequate slab freeboard and good quality concrete well, compacted and placed.

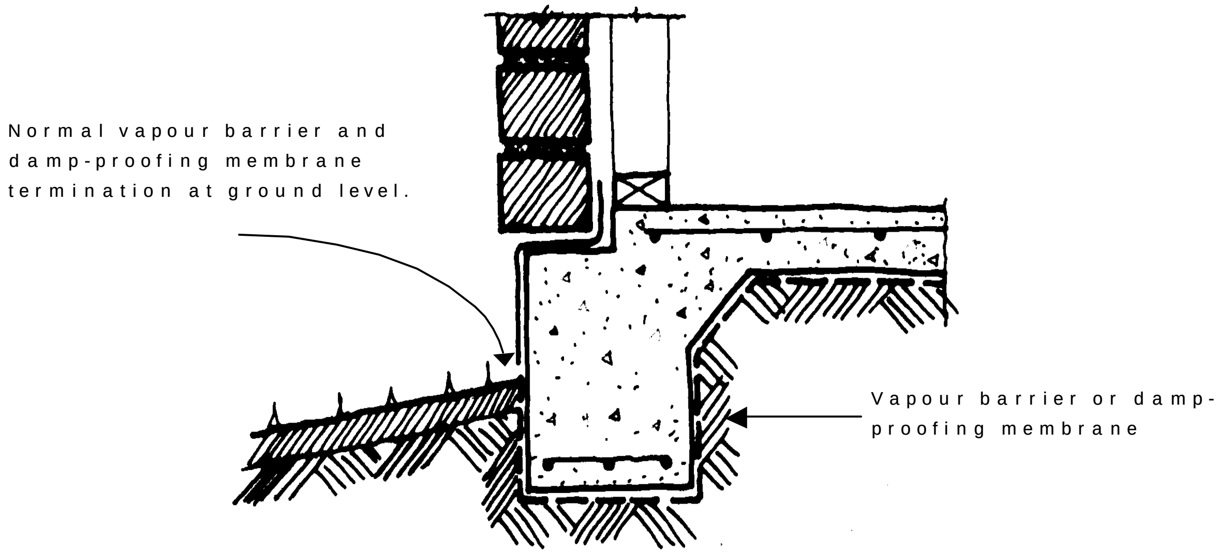


Fig 3 Slab Vapour Barrier

Problems may also occur where surface drainage is not effectively directed away from the building. The potential exists for higher MC in these localised areas or indeed the potential for flooding in certain situations. This "slab edge dampness" is not uncommon and can be exacerbated with large windows warming the slab and drawing moisture to the surface. One potential solution where the slab edge MC is not greater than 10% is to coat the surface with an epoxy coating or equivalent to protect against moisture problems.

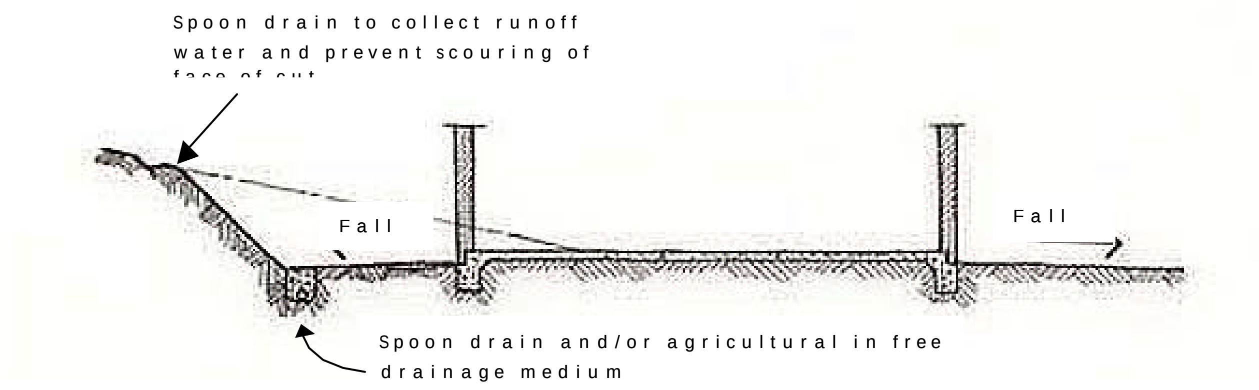


Fig 4 Surface Drainage

Exposed concrete balconies potentially impact on the moisture content of the typically attached internal slab. Where the balcony is exposed, testing for moisture content within a close radius of the internal/external junction ie near the doorway - should be carried out. This is particularly relevant where there is no step down to the external balcony - in these cases there is an additional issue of the balcony potentially flooding water into the dwelling during heavy rain.

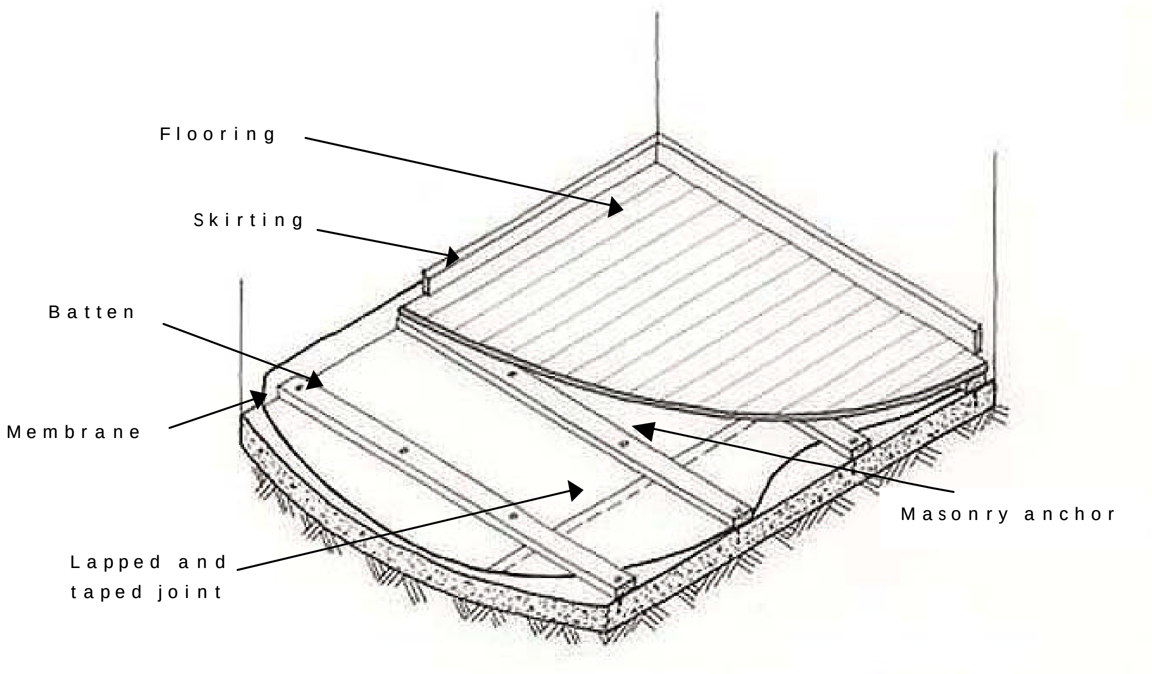


Fig 5 Battens Fixed To Slab Over Membrane

1.5 Bearers and Joists

The level of the floor frame must be suitable for the installation of the strip flooring. In many cases this is the responsibility of the builder. To assess the frame, a number of alternatives exist. The most commonly used method is to place a straight edge of a minimum of 3 metres on top of the joists and assess the various high and low members. The joists can be planned down if high or packed if too low. Care must be taken to ensure that the joists are not reduced in sectional size below that required under AS1684. This same structural requirement prevails in cases where the joists are "crippled" ie cut through over a support to reduce the bow in the timber.

Where a single joist is well below the other members, a secondary joist can be fixed to the side of the original. This member should be nailed or screwed to the original in accordance with AS1684 nail lamination requirements

1.6 Steel Floor Joists

Where steel floor joists are encountered, the recommended practice for fixing strip floors is to screw fix the battons to the steel joists at min 600 mm centres a timber section of minimum 35mm in thickness, to the top of each joist - The flooring boards can then be fixed to the joists in the conventional manor.

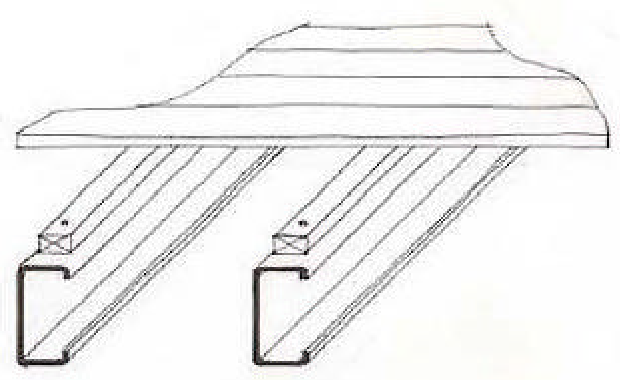


Fig 6 Timber Batten Over Steel Joists

1.7 Steel Beams

In many open plan floors, timber floor joists are supported with a steel beam. The issue of differential shrinkage is the primary concern where the steel beam remains relatively inert whilst the timber may swell and shrink marginally with variations in moisture content. Where the joists have been simply fixed level with the top surface of the beam, any variation in moisture content has the potential to reveal a "hump" in the floor surface over the steel beam. The potential problem should be highlighted to the builder/owner before proceeding with the floor installation. It should be pointed out that all timber elements, be they seasoned or unseasoned, will move relative to the steel members. Unseasoned products will require additional clearance as compared with seasoned product and engineered products.

A more appropriate detail for this scenario is detailed below.

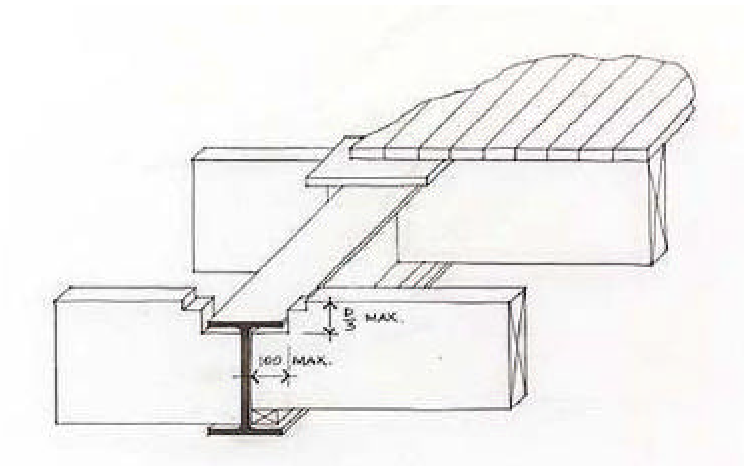


Fig 7 Section - Steel Beam / Timber Joists

1.8 Changes in Joist Direction.

Floor joists are normally fixed in the one direction, however, given the many variations of floor plans and renovations, joist direction may vary. It may not be acceptable to alter the direction of the boards at the exact location of the joist direction change. The more appropriate location could be at a doorway, dividing wall or as dictated by the owner or builder.

The common way of maintaining the laying direction of the boards, where there is a joist direction change, is through the use of blocking. Timber of the same type is fixed at the appropriate spacings between the joists. The fixing is critical as any settlement could impact on the performance of the floor with potential humping over the joists and severe floor squeaks. An appropriate method of supporting these blocks is through the use of joist hangers. These are available in a range of sizes to suit the more commonly utilised section sizes.

1.9 Moisture Content - Assessment of Site Conditions.

Floors fixed over bearers and joists will potentially gain or loose moisture in response to the existing sub-floor conditions. Traditionally, once the house had reached a weatherproof stage, the timber floors were cut in, turned upside down and left as a working platform for the period of the construction. Whilst these boards would have received some moisture impact from various trades, they would typically achieve a state of equilibrium with the house microclimate. This process of the board achieving equilibrium over a period of time is known as “acclimatisation”.

Acclimatising timber in concept is an ideal way to ensure a floor, which will remain stable and perform suitably in service. The key issue is that the boards must be acclimatised to the conditions expected in the long-term service of the building. For this to be the case, aspects such as sub-floor ventilation, stormwater connections, air-conditioning, slab heating etc need to be completed and operating in order to provide the anticipated internal climate conditions.

An example of where this process can go horribly wrong is outlined below:

The boards are delivered at 12% moisture content, cut into there respective rooms, turned upside down and acclimatised for a period of four weeks prior to fixing in place. During this time, the sub-floor area is awash with stormwater from the in-completed system. The renderers are using the boards as a working platform and the air conditioning is not running. The weather is very wet throughout the acclimatising period. The board’s moisture content is now 20 % with the associated increase in dimensions.

The boards are fixed in place, the stormwater is connected and the air conditioning is running. The boards are drying out to the new service conditions. The subsequent shrinkage and gapping between the boards is 4-5mm as the boards reach their service moisture content of 10%. In these circumstances it is clear that acclimatising boards must be to their anticipated service conditions and not as a mindless process.

Where the service conditions are confirmed ie water tight building envelope, stormwater connected (or at least not running under the building) and the wet trades are completed, the boards can be cut in and turned over and pinned. The floor can then be used as a working platform for any dry trades ie plasterboard, painting, electricals etc. Over the two to three week period of use as a platform the boards will have stabilised to the site conditions and can now be turned over and fixed in place. This will leave the finished face of the board in a relatively untouched condition ensuring a good quality finish.

NOTE*: *Where the moisture content of the boards is known and the conditions of the room or area are also known in terms of moisture content and typical ambient conditions, the boards may be installed without any acclimatising period. This is only appropriate where the MC of the boards and the room are approximately equal - a range of +/- 1% would not be problematical in most situations.

1.10 Protection of Floor During Building Works

In many cases, the floor will be used as a working platform for trades during the construction of the building. The concept is that the floor will be sanded and coated on completion of these trades work with any blemishes being removed during this process. It is very important to notify the builder/owner of the need to protect the boards as far as possible during this construction stage. Many of the products utilised by the building industry may damage the boards in a way, which may not be redeemable. Products such as plasterboard setting compounds can stain various species of timber to a depth, which cannot be removed with the sanding process. Silicone sealants can affect the bond between the surface coating and the timber.

Additionally, mechanical damage is common from scaffolding, ladders, dropped materials and tools. These indentations may be potentially quite deep and not removable with conventional sanding.

Timber floors may also change colour slightly due to UV exposure - sunlight. The boards typically darken slightly from UV exposure and hence may affect only those areas exposed. Where a protective layer is placed over the boards ie cardboard - and the floor has some exposed areas - the areas protected by the cardboard would typically be slightly lighter in colour than the exposed boards with the same UV exposure. This discolouration will tend to even out with the body of the floor over a period of time.

1.11 Air-conditioned Buildings

Air-conditioned buildings typically present an environment of very low humidity. The timber, as previously noted, will acclimatise to these conditions. As for heated slabs, the impact upon the boards will vary depending upon the frequency of use. In a commercial building, air conditioning is run for the large proportion of time and offers a fairly stable environment for the timber floor. In such case, acclimatising the boards to these conditions or having them dried down to the appropriate MC before delivery would be appropriate.

In residential applications, air conditioning is typically utilised in extremes of weather - ie when its very cold or hot. Where this is the case, the boards would be more appropriately acclimatised to a non air-conditioned state. The occupants should be advised of the potential gapping of the boards if the air-conditioning is used for prolonged periods.

1.12 Methods for Testing Moisture Content

Where a building has reached its service conditions or where boards are being replaced in an older building, various methods exist for measuring the ambient moisture content.

1.12.1 Moisture Meter

The moisture meter is a very simple method of obtaining a reliable measure of conditions on site. The meters are typically of the penetrative type, which measure the electrical resistance of the material between the two penetrative prongs. The result is reflected in either a needle or digital readout in increments of percentage points of moisture. The result needs to be adjusted in accordance with the tables supplied with the meter in relation to the specific timber species being tested.

Capacitance moisture meters use a radio frequency oscillator to supply power to make their measurements. They do not do any damage to the surface of the timber and work reliably on material of similar densities.

Measuring the moisture content of the installed joists is a suitable method given that they will have acclimatised to their surrounding conditions over a long period of time. The problem is that the joist species may not be readily identified and the result will vary depending on this knowledge via the adjustment tables. This being the case, the results can give only an indication of moisture content. Potentially, these results will be adequate for the assessment process.

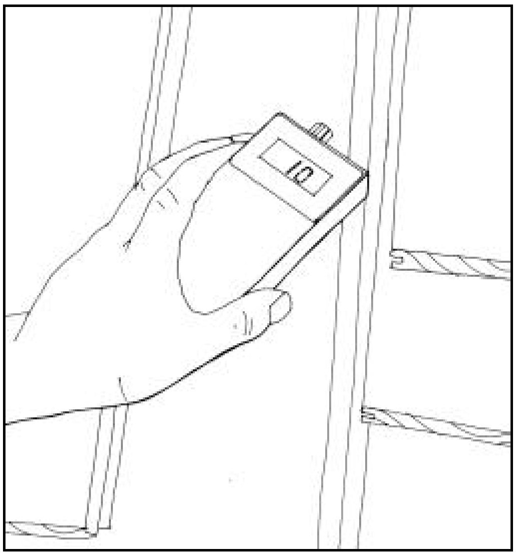


Fig 8 Capacitance Moisture Meter

SECTION 2 MEASURING THE PROJECT

To estimate the quantity of flooring required for a job, the floor is simply measured in its length and breadth (in metres) with these two figures multiplied together. The area is then shown in metres squared. If the area comprises of an irregular shape, the approach is to divide the room into square or rectangular areas and carry out the same multiplication for each of these areas. The figures are simply added together to give a total number of metres squared of floor area. (refer below).

The floor area then needs to be converted into lineal metres of board including an appropriate allowance for wastage. For example, using 80mm cover width flooring simply divide 1000mm by 80 = 12.5m. Multiply this figure by the total number of metres squared to give net lineal metres. Wastage will vary depending on the complexity of the room however a typical allowance is 5% for end-matched boards and 7 - 10% for plain boards.

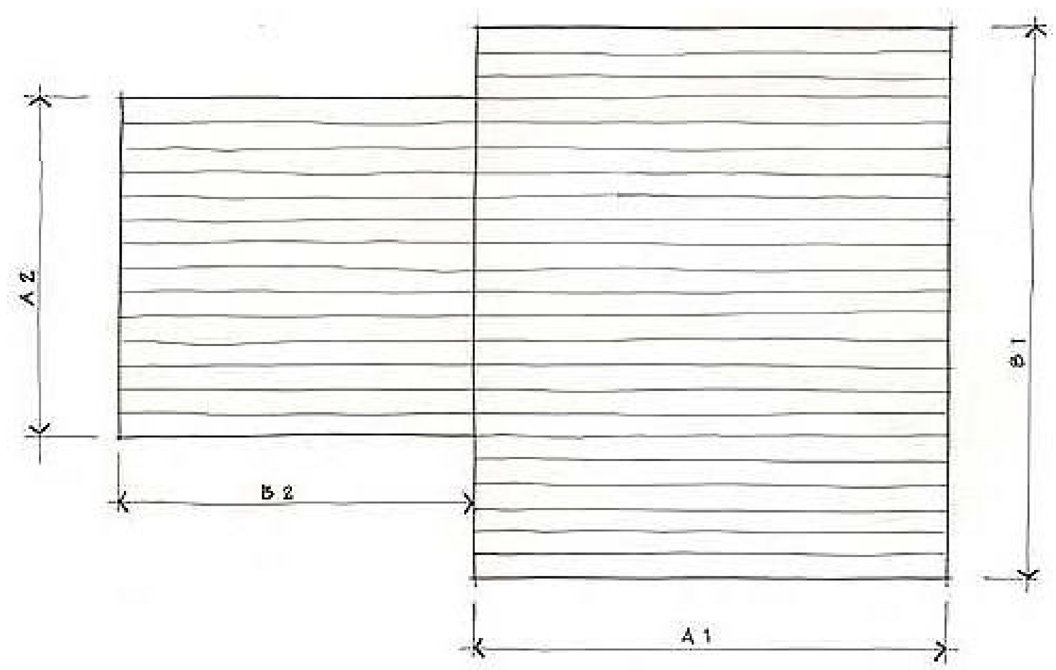


Fig 9 Measuring The Job

$$(1000/80) \times [(A1 \times B1) + (A_2 \times B_2)] \times (1 + \text{waste factor})$$
$$\text{eg: } (1000/80) \times [(3 \times 3) + (4 \times 5)] \times (1 + 0.05)$$

SECTION 3 INSTALLATION OVER BEARERS AND JOISTS

3.1 Delivery

The order of delivery must be timed so that the timber is not left exposed to the elements. A pack of timber, even when wrapped in plastic can be impacted by the microclimate where it has been stored along with the propensity to "sweat" where it is left exposed to the direct sunlight. The preferred delivery is to simply cart the material from the delivery vehicle directly to the area of laying or at a minimum, into an area of similar temperature and humidity. Care must be taken regarding damaging the boards in this procedure.

3.2 Starting the installation

The direction of the boards over floor joists is primarily set by the direction of the joists. The boards are typically laid at a 90-degree angle to the joist run. Boards may be run at alternative angles however any variation from 90 degrees increases the actual span covered by the board. It must be ensured that the span does not exceed that permitted under AS 1684 for a given board type and thickness.

Table 3 Structural Flooring – Maximum Allowable Spacing Of Joists

Flooring	Standard	Grade	Thickness (mm)	Maximum spacing of joists (mm)	
				Butt Jointed	End Matched
Strip flooring					
Western Australian hardwoods	AS2796	Standard Select	19 19	620 680	470 520
South-eastern Australian hardwoods	AS2796	Standard Select	19 19	620 680	470 520
North-eastern Australian hardwoods	AS2796	Standard Select	19 19	64 680	490 520
Other hardwoods -Density less than 560 kg/m^3 - Density greater than 560 kg/m^3	AS2796	Standard Standard	19 19	510 580	390 450
Australian-grown conifers -Density less than 560 kg/m^3 -Density greater than 560 kg/m^3	AS1782	Standard Standard	19 19	510 580	390 450
Australian grown conifers -Density less than 560 kg/m^3 -Density greater than 560 kg/m^3	AS1810	Grade 1 Grade 2	19 20	510 580	390 450
Cypress	AS1810	Grade 1 Grade 2	19 20	580 580	450 450
Radiata Pine	-	Merchantable Standard Standard	19 19 30	450 510 920	- 390 700

***NOTE**: Typically the construction industry works to standard joist spacings of 450mm and 600mm.*

Sort the boards into stacks; boards of similar length and of varying lengths. Any boards found to be damaged should be removed or have the damage docked out.

Setting the initial board in a straight alignment is of key importance. This first board will generally be started in parallel with the longest wall maintaining a minimum 10 mm gap between the wall and the edge of the board. Make a mark 10-12 mm in from the parallel wall and at the extremity of the wall ie in the corners. Fix a nail into the marks. A string line should be set along this point and ensure that the angle is 90 degrees to the direction of the joists.

Fix the first board with its groove towards the wall and with the edge aligned with the string line. A minimum gap of 10mm between the edge of the board and the wall is required as a precaution for possible expansion of the boards where they increase their moisture content. (*Refer Control joints Section 4)***.** Ensure the board has no deviations from the string line as any variation will be carried through the body of the floor. If necessary, temporarily fix a nail to each joist along the string line. The boards can then be pushed against this line of nails to remove any minor bowing and ensuring a straight and square first row of boards.

***NOTE**: ensure that the nails are both adequately secure and of sufficient length to be removed on completion of the first two or three rows of installed boards*

Start with the varying length boards, longest first, in a triangular or "rack" from one corner. Continue each row by laying the similar length boards in each row, adding and cutting short lengths to finish the row. There must be at least 450 mm distance between butt joints in adjacent rows. Where boards are end matched they may have these joints between the joists provided that the end joints are well distributed and end-matched joints in adjoining boards do not fall within the same joist spacing. Board lengths shall be at least the equivalent of two joist spacings.

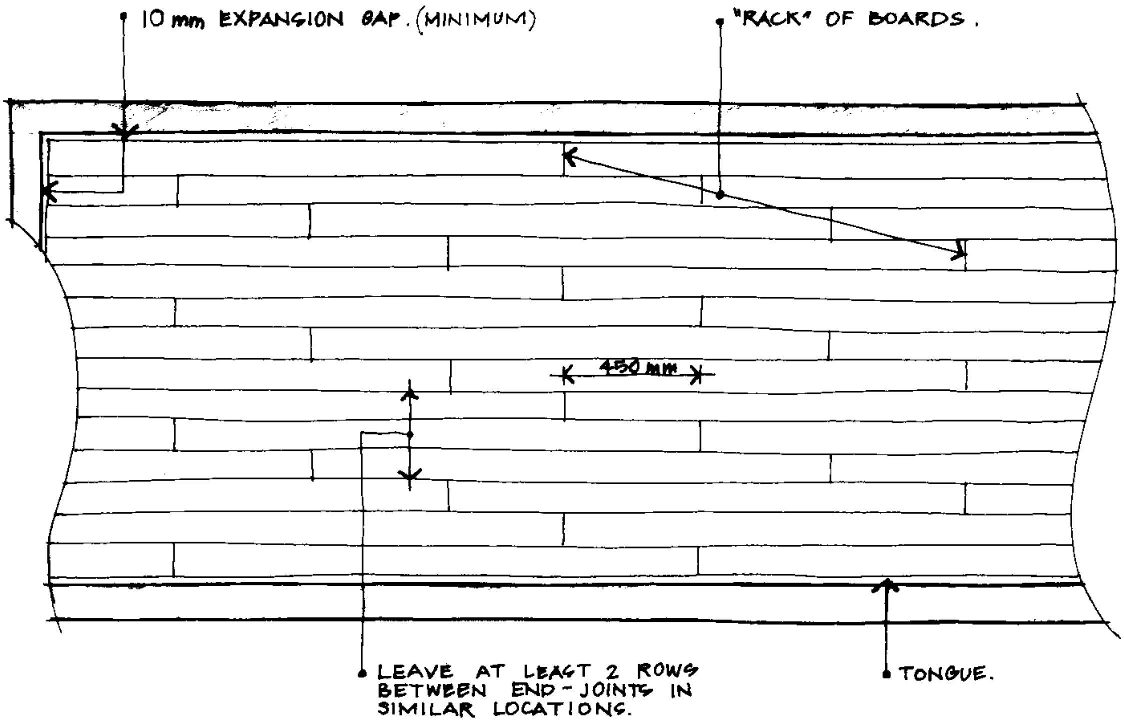
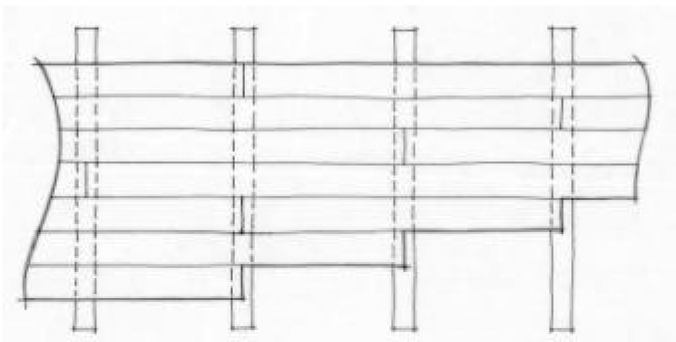


Fig 10 Diagram Showing Board Layout And End Match Board Locations. Board Racking Typical



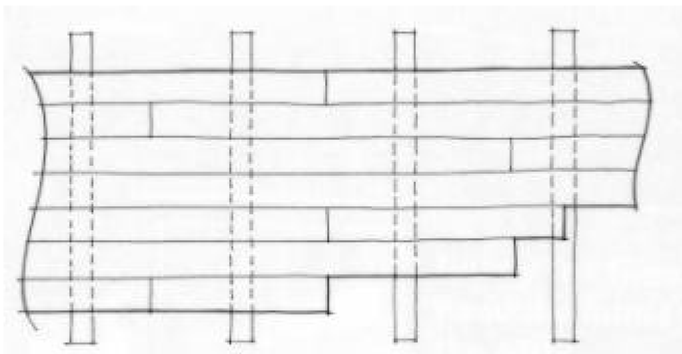


Fig 11 End Matched And Butt Joints - Joint Location

Ensure that end joints, both butt and end matched, are evenly distributed and do not cluster in any one section of the floor. Ensure all end joints are tight closing any gaps by tapping on the opposite end of the board. Top nailed boards require cramping together to remove any gapping between the boards and to take out any misalignment in the individual boards. The optimum tool for this work is a flooring cramp. These tools are secured to the joist and can apply gradual horizontal pressure to the edge of the board. An off cut of board should be utilised as the transfer member between the cramping tool and the board edged.

As a rule of thumb, the width of boards being cramped should be a maximum of 900mm. The pressure should be adequate to close any gaps between the boards unless the boards have some out of tolerance milling. The pressure should be applied until the mid board just lifts from the joist and then backed off until this board settles onto the joist or baton. There should be full contact between the boards and the floor frame. Where the width of boards exceeds 900mm, the potential for the boards to "float" above the joists in the middle section of the cramped group is increased.

Cramping pressures may need to be varied according to the prevailing local conditions - ie during prolonged dry weather, with boards that have acclimatised to these conditions, the boards should be more loosely cramped as compared to boards installed during damp conditions.

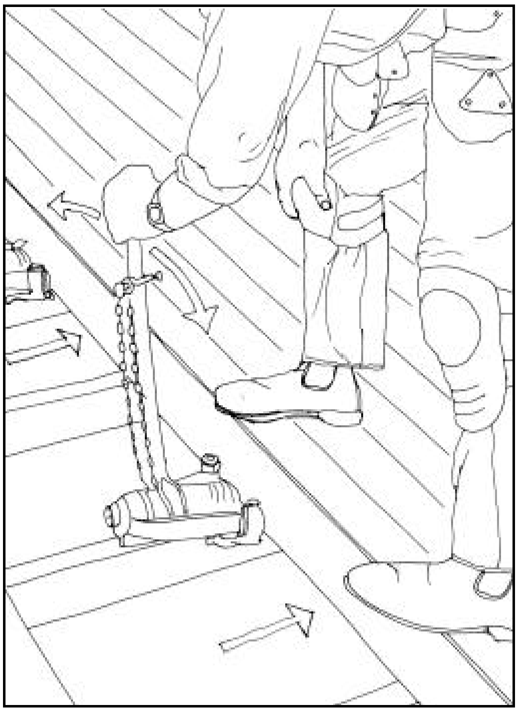


Fig 12 Cramping Floor Boards

Secret Nailed floors are nailed through the tongue at a 45 degree angle, with the fastener being covered over with the next board. As the board is only secured with a single nail per joist, wide boards are not suited to this type of fixing method. AS 1684 limits the width of secret nailed board to 85mm cover width. Boards exceeding this width shall be fixed with two face nails per joist. The specialist secret nailing gun will press the individual board against the previously fixed board as it fires the fastener, avoiding the need for cramping groups of boards.

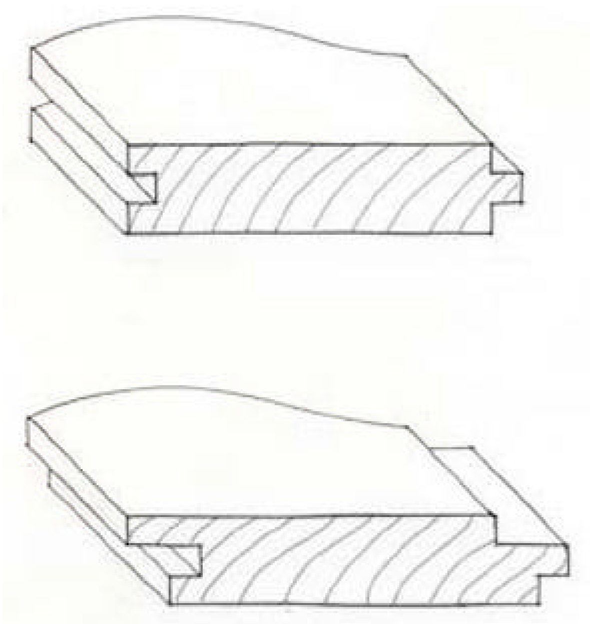


Fig 13 Board Profiles

3.3 Fasteners

AS 1684 requires minimum nail dimensions for the fixing of flooring to floor joists. These requirements are set out in the table below

Table 4 Fastener Requirements

a. Nail sizes for fixing tongue and grooved flooring to joists

Nailing	Softwood joists	Hardwood and cypress joists
Hand driven	65 x 2.8 mm bullet head	50 x 2.8 mm bullet head
Machine driven	65 x 2.5 mm	50 x 2.5 mm

b. Nail Sizes for fixing tongue and grooved flooring to structural plywood underlay

Strip flooring thickness (mm)	Recommended nailing (for 15 mm minimum thickness subfloor)
19 mm or 20 mm	Either 38 x 16 gauge chisel point staples or 38 x 2.2 mm nails at 300 mm spacing
12mm, 19 mm or 20 mm	32 x 16 gauge chisel point staples or 30 x 2.2 mm nails at 200 mm spacing

Overlay floors or flooring fixed to battens over a structural substrate ie a concrete slab, may utilise alternative fasteners based on these alternatives being fit for purpose. Information regarding the suitability should be provided by the manufacturers of these products along with any specific procedures for their use.

3.4 Nailing Procedure

3.4.1 Top Nailed Boards

Having cramped and secured the boards ensuring that the boards are in full contact with the floor joists, drive the first row of nails into the board at an angle slightly skewed (10 degrees approximately) from the vertical. The first row of nails should be installed into the last board ie next to the floor cramps. The nailing should continue along this line of boards and then return with the second line of nails at the reversed angle of skew - refer the diagram below. This nailing process should then proceed in an identical manner along each row of boards up to the end of the cramped group of boards. After nailing off or fixing the group, the next group of boards is laid out as previously outlined, cramped and fixed.

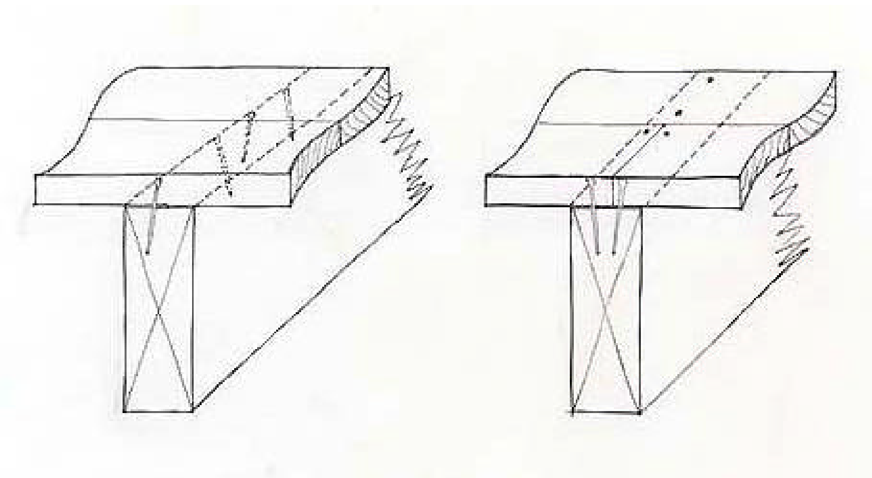


Fig 14 Nailing Diagram

Depending on the species, end nailing at the but-joint can cause splitting of the board. As a prevention method, it is good practice to pre-drill the nail holes through the full depth of the board with a drill hole 0.5 - 1 mm smaller diameter than the nail.

Care should be made in maintaining the line of nailing so that a precise appearance is the end result. Where nails are proposed to be in line, a string or pencil line should be set for reference so that the nailing line is maintained. If staggered nailing is proposed, care should be taken in maintaining the same positions of staggering so that a uniform appearance is the end result.

At regular intervals a check should be made to confirm the boards are being laid square. Small variances in cramping pressures between one operator and another as well as, milling variances can cause the floor to “creep” out of square. This may not be obvious in the middle of the floor area however as the progress of laying nears a parallel wall, the variance will become obvious.

Depending on the extent of the error, correcting this situation may either require some correction in the installation process, ie slightly adjusting cramping pressure to the side which needs to increase its overall width whilst maintaining full, or tight cramping to the other portion of the floor. Over a number of boards the situation may be resolved. Care is required not to exaggerate the variance in cramping pressure.

In cases where the floor is excessively out of square and visually obvious, the boards should be taken up back to either a square point or alternatively to a position where a corrective cramping measure could be undertaken successfully.

Nails should be punched a minimum of 3 mm below the surface of the board so that they are not impacted on by the sanding process. The punch should be of a size, which neatly fits the nail head minimising the diameter of the nail hole requiring filler. For very fine nails - ie where the last few boards of a secret nailed floor require top nailing - the punch diameter minimum will typically be 3mm. Where a nail gun is utilised, the nails should be hand punched to ensure that the boards are firmly seated to the substrate.

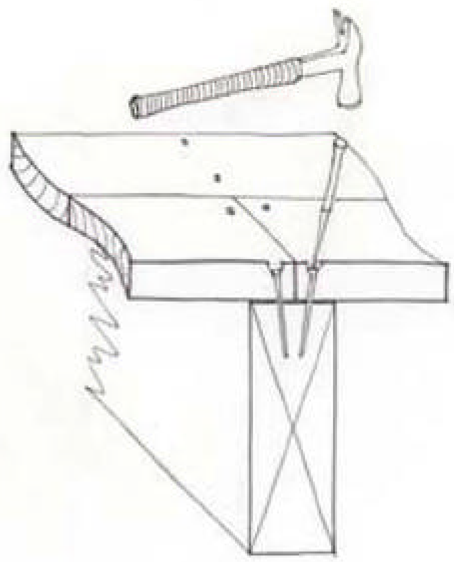


Fig 15 Nails Being Punched

3.4.2. Secret nailed boards

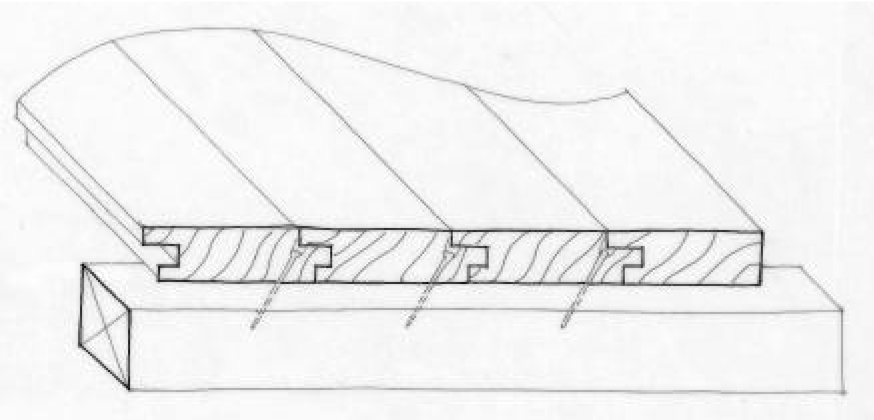


Fig 16 Secret Nailing Profile

Secret nailed floors generally start off by top nailing the first one or two boards and then reverting to the secret nailing gun. The gun fixing method compresses the board against the previously fixed board, working on a board-by-board fixing technique. The nail is effectively concealed or “secret”. Care should be taken to ensure the boards are kept square as any variances in application technique by the operator can cause the boards to creep out of square.

The use of structural grade adhesive is recommended in conjunction with nailing where a more “integrated” floor is desired.

NOTE*: Only specific secret nail profiles may be secret nailed (i.e. secret nail profiles).*

3.5 Control Joints

Timber will increase and/or decrease in its dimensions due to variations in moisture content. The boards acclimatise to the prevailing conditions within the environment in which they are laid. As a precaution, timber flooring shall be installed with a minimum gap of 10 mm between the edge of the board and any vertical barrier such as a wall, steps, tile thresholds, posts, door sill etc. Generally, this gap is concealed by the skirting board or where exposed may be filled with a compressible filling material such as a mastic, cork or similar material coloured to suit the species of flooring used. In cases where a wider gap is possible (ie where the boards are installed pre plasterboard) or where large section skirtings are proposed, the opportunity to provide this wider gap should be taken.

Wide floors require additional precautions in regards to these control/expansion joints. Floors over 6 metres in width measured at right angles to the flooring require additional intermediate expansion gaps in addition to the gapping against vertical surfaces. Additional control joints are required for each successive increase of six metre widths. The reason for this additional control joint in these wide floors is that any increase in moisture content is compounded in relationship to the width of the floor eg. if a floor is 9 metres in width and the boards affective cover width of 86mm then there is a total of 105 boards. Over a 3 metre width of boards, a 1% moisture content increase will relate to a 7-10 mm increase in overall width. Therefore if the floor is 9 metres in width a change in overall width of 21 - 30 mm will occur. The allowance of a minimum 10mm gap against each side wall would not be adequate without additional control joints and would place unacceptable pressure on fasteners of the outside boards.

NOTE: Much of this movement is taken up in the joints and edge crushing between boards.

The location of the control joint can in many cases, fit in with the floor plan of the building to minimise visual impact. Where possible these joints can be located in door thresholds or in alignment with another structural element such as a dividing wall or staircase. The mid-floor control joint can be finished in various ways to minimise any visual and aesthetic issues. Where the joint is filled, the filler should be of a compressible material, which is of a colour to blend in with the floor covering. Alternately, a cover strip can be utilised - this strip may be a “H” type metal extrusion which is recessed into the joist with each boards edge being set into the extrusion. The down side of this type of joint is the problems it creates in finishing the boards.

NOTE*: Where a cork or compressive mastic are utilised, care should be taken in ensuring that the filler cannot fall out of the joint in periods of dry weather when the boards may shrink due to reduced moisture content. Cork also tends to absorb the finishing coat leaving a dull strip in an otherwise glossy floor.*

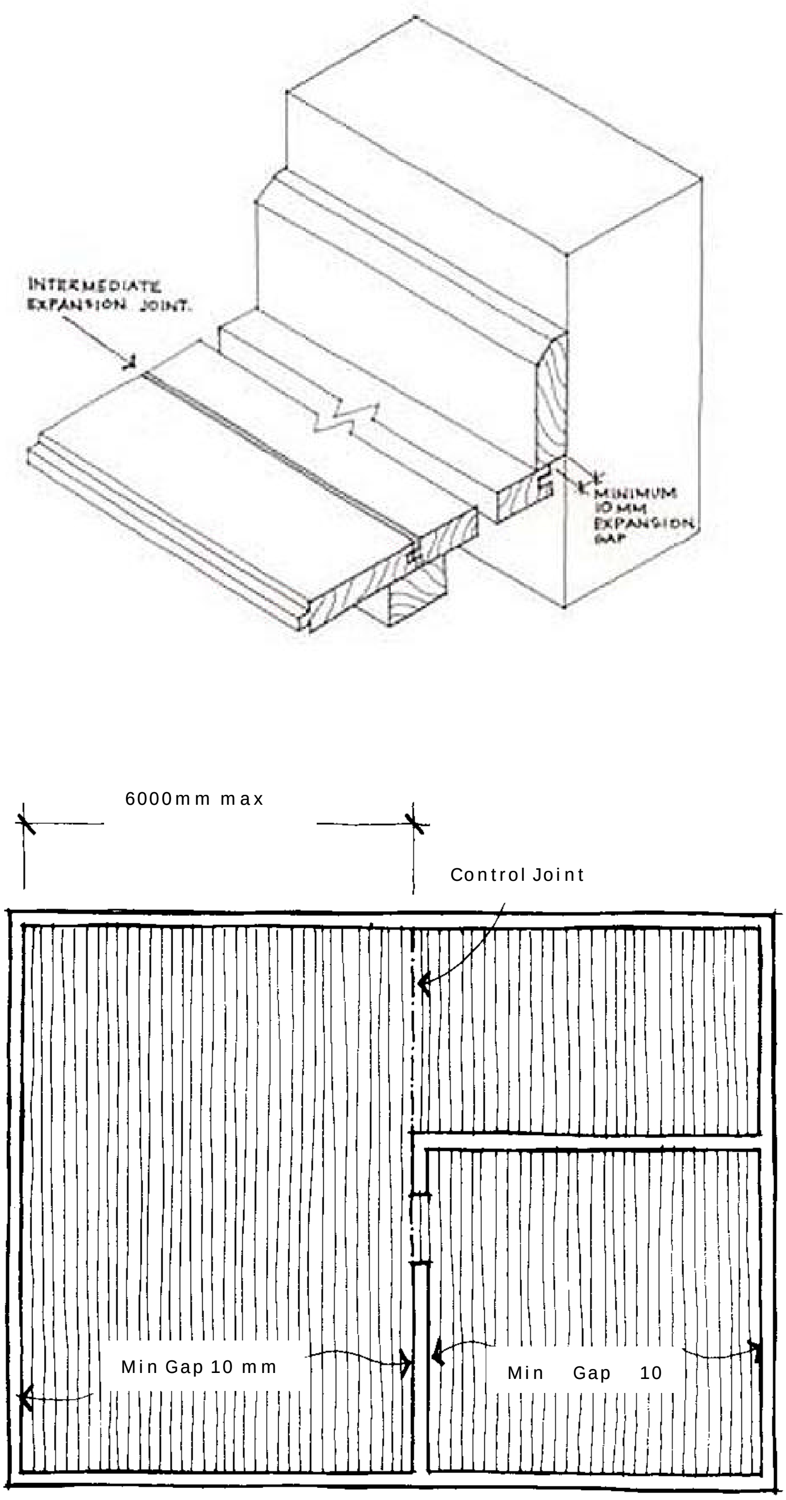


Fig 17 Control/Expansion Joint

SECTION 4 INSTALLATION OVER CONCRETE SLABS

4.1 Slab condition

The concrete slab needs to be sufficiently sound, dry and level for the installation of timber flooring. A method of assessing the flatness or level of the slab surface should be utilised to ensure that the surface has minimal deviations. One such method is to use a 3 metre straight edge where no part of the surface should be more than 5 mm below the straightedge. Any major variances will need to be filled or alternatively the batten or sheet underlay bridging over these hollows will need to be packed. Where this approach is utilised it is imperative to ensure that the batten or sheet underlay is sufficiently supported so that the finished floor does not deflect excessively at these points. High points on the slab surface may require grinding.

Where a topping compound is utilised for leveling purposes, the product must be suitable for the loads imposed by the flooring.

4.2 Delivery

Delivery of the timber flooring should not occur until all wet trades are completed, storm water system is completed and the slab has been assessed for its moisture content. Additionally, where any leveling compound was required for levelling the slab, the compound has been given adequate time for curing and is sufficiently dry for the flooring installation to proceed. Delivery and exposure of boards to high levels of humidity, caused by the aforementioned issues would increase the moisture content of the boards and lead to major problems. Storage of the boards on site also impacts on the moisture content where this environment varies from the condition of the room(s) in which the floor is to be installed. Store boards either within the area in which they will be laid or alternatively in an area which has the similar environmental conditions.

4.3 Fixing Methods

Conventional tongue and groove timber strip floors are generally not fixed directly to concrete slabs. The two current alternatives used to provide the fixing strata are timber battens spaced at the centres required for the species and board thickness used or plywood sheeting. Timber battens allow for a choice of either top nailed or secret nailed fastening. Plywood underlay (depending on thickness) is suitable for secret nailing only as it does not have the required thickness for top nailing and conventional floor cramps cannot be utilised, as is common, for top nailed boards.

NOTE**: A polyethylene membrane of minimum thickness of 200 microns can be used as an additional protective measure against impact from slab moisture. Overlap joints a minimum of 200 mm and seal with duct tape. The membrane should be carried 75 mm up the walls and trimmed on completion of the floor.* ***The installation of the membrane does not overcome a wet slab!

4.3.1. Timber Battens

Timber battens should be anchored to the concrete slab in accordance with the Table 5. In all cases, a seasoned product should be specified in order to minimise any movement of the batten in service. An Unseasoned batten material could shrink causing some gapping between the boards and the batten allowing movement and potentially squeaking. The battens need to be of a sufficient size to accept the fastener used in fixing the boards to the batten. It is logical then that a thinner batten is acceptable where secret nail fastening is used as the nail penetrates at an angle into the batten rather than the top nailing process where a deeper batten section is required.

The battens should be anchored at centres in accordance with Table 6 utilising an expansive type concrete / masonry anchor of a minimum 6 mm diameter. Chemical anchors are also suitable however; the installation practices specified by the manufacturers of these products may be less practical than the expansive type. The length of the anchor will vary from 40 - 110 mm depending upon the batten thickness and the surface conditions of the slab. A construction adhesive may also be used to increase the connection between the slab and the batten in addition to the mechanical anchors. Simply using a nail driven into a plastic dowel is unacceptable.

It is good practice to stagger the fixing locations to minimise any potential movement of the floor system should one anchor become loose.

Table 5 Spacing Of Anchors For Battens

Batten density Kg/m^3	Maximum distance between anchors mm
More than 600	900
Less than or equal to 600	600
NOTE: The anchors should be properly installed so that they are tight. Loose anchors should be disregarded and replaced.	

***NOTE**: Additional care should be taken where the slab is heated. Anchor lengths should be specified so that there is no possibility of impacting on the heating system. Where slab heating* *is utilised, selection of timbers with low shrinkage rates can be less problematic. The timber will be placed under a wide range of conditions depending on the frequency of use and temperatures settings of the heating system. In all cases the MC of the boards will vary with this usage and board movement will be experienced.*

***NOTE**: Many services may be run through the slab such as electrical conduits and cable, water pipes and telecommunication wires - Care should be taken in seeking advice (where possible) from the builder/contractor or other informed person regarding these services.*

4.3.2 Plywood

Plywood offers the benefit of giving a continuous fixing medium over the slab surface. The floorboard direction is not governed, as is the case with battens, offering greatly improved flexibility for timber boarders and the like. The continuous nature of the underlay also reduces some of the “hollow” noise that can be present through foot fall on timber floors over battens. The minimum recommended thickness for plywood sheeting is 12mm.

The plywood needs to be adequately supported by the slab substrate. As a guide, any undulation over a 1500mm straight edge length should be less than 3mm. Unlike a battened floor, minor undulations will not be visible once the plywood is in place and these can impact on the performance of the finished floor. Undulations in the concrete slab will need to be either patch topped or suitably leveled prior to installation of the plywood underlay. Any topping or patching compound, if water based, will need to be tested for moisture content and confirmed as suitable before installing the plywood. High spots in the concrete surface can be ground off.

4.3.2.1. Fixing the plywood to the substrate

The plywood sheets should be laid out in a diagonal brick bond pattern leaving a 3mm gap between the sheets and a 10mm gap between the edge of the sheets and any vertical surfaces such as walls, steps, posts etc.. String line the locations for the anchors insetting 50 mm from the edge of the sheet and then at maximum 600 mm centres. At the pre-determined anchoring locations, the plywood should be counter bored with a hole size adequate to ensure that the anchor head will not protrude above the surface of the plywood on installation of the anchor.

The holes are now drilled to accommodate the expansive type anchor of a minimum 40 mm in length. Ensure that the hole depth is adequate for the length of the anchor. Install the mechanical anchor. The nylon impact type anchor have been widely utilised for this application and offer a very quick installation procedure.

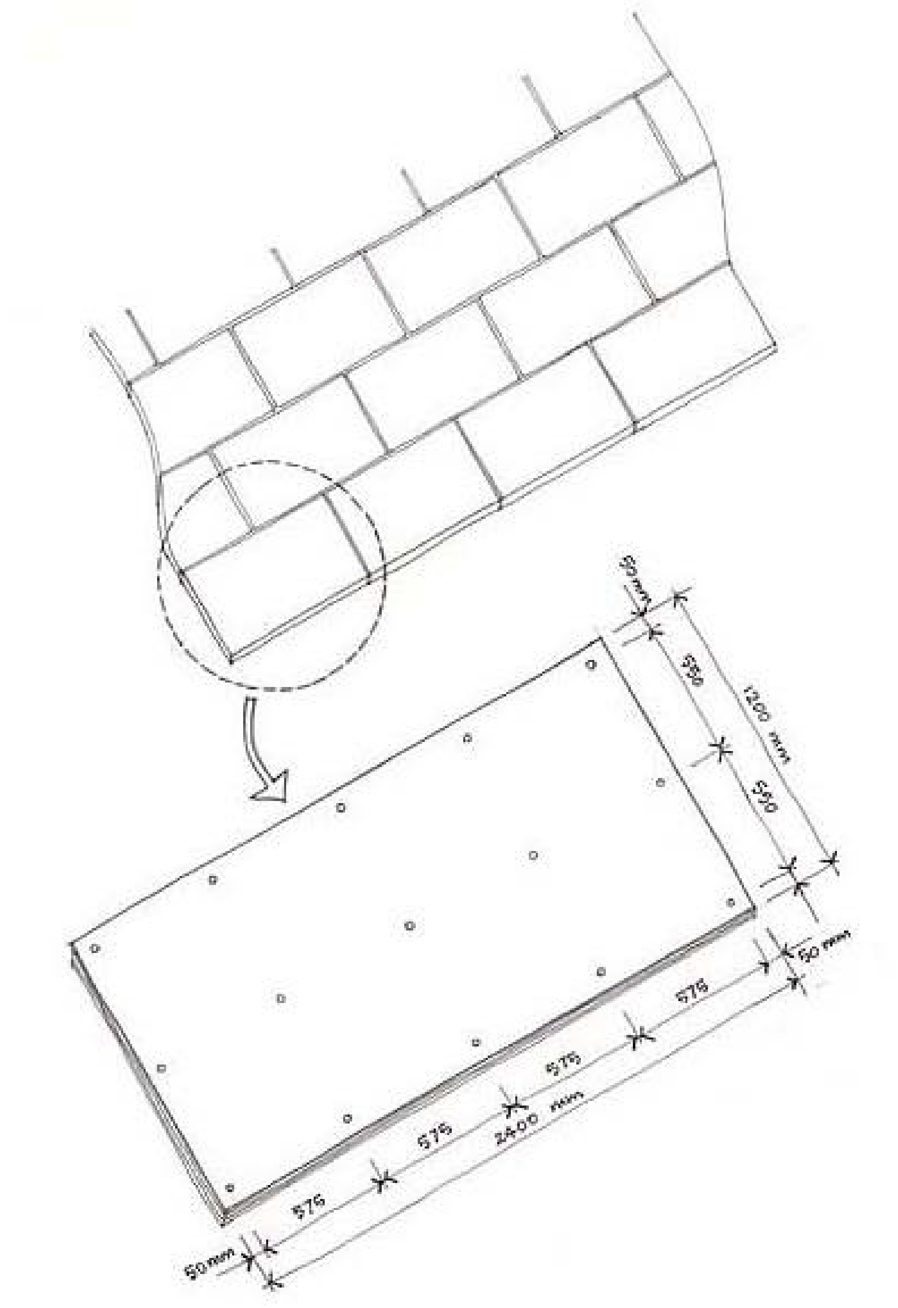


Fig 18 Fixing of Plywood Sheets

NOTE: *Additional care should be taken where the slab is heated. Anchor lengths should be specified so that there is no possibility of impacting on the heating system.*

NOTE: *As is the case with the timber flooring, the plywood sheets will also absorb or dispel moisture to equalise with the environment in which they are kept. Where the conditions on the site are unknown in terms of moisture, the plywood should be given time to acclimatise with the microclimate of the laying area.*

4.4 Waterproofing Membranes.

On slabs that have a higher than acceptable moisture content or are potentially subjected to water, a waterproofing membrane may be an acceptable method for controlling this problem. It should be noted that even with the best attention to detail and thoroughly following the manufacture's recommendations, a breakdown or weakness in the waterproofing system could impact on the performance of the timber floor.

The selection of a suitable membrane should be based upon the specific requirements of the application. For example, a slab in a basement area may be impacted with water with a degree of hydraulic head. The water is being forced into the structure and any membrane selected will need to have a capacity to withstand this pressure. In all cases, the installation procedure shall follow the manufacturer's instructions. Additionally, the product should be specified by the manufacturer as being suitable for the purpose intended - ie as a barrier to moisture in applications using timber floors fixed over the membrane. The key property of the membrane is water vapour transmission rate.

NOTE: *Waterproofing membranes typically do not completely seal the slab surface from moisture vapour penetration. In most cases they reduce the rate of penetration hopefully to an acceptable level. Many of these products are not aimed at being suitable for a timber floor system which is highly impacted by changes in moisture content, with less susceptible floor finishes being the assumed market.*

4.5 Heated Slabs

Slabs, which have heating elements, attached to the reinforcement of the slab pose certain problems for the performance of a timber floor. When in use, the system invariably lowers the moisture content of the timber. This is OK where the slab heating is in constant use and the temperature is regulated as the timber can be acclimatised to these conditions prior to fixing. However, the reality is that the systems are not used year round and the timber may pick up 3 or more percent MC between the cycle of being in operation and out of operation. As a result, substantial board movement will result.

There are two options, which are in use in the market. The first approach is to install the boards in a typical set of conditions without the slab heating in operation and then expect the boards to gap during the operation of the slab heating. The other approach is to set the heating system to a set of conditions typical of the in service situation, acclimatise the boards over the floor to these conditions and then nail the boards in place. You would then expect some growth in the boards during the period where the system is not in operation.

SECTION 5 SANDING AND COATING

5.1. Finishing the Boards

The sanding and finishing of the boards is an area, which offers a wide array of methodologies and coating systems. The practices described are those employed broadly throughout the industry, however variations on sand paper grades and procedures are common. The aim in all cases is to provide a smooth surface with the desired surface coating suitably applied to give an even level of sheen across the body of the floor.

In all cases, it is good practice to let the floor "settle" for a period of 3 - 7 days before the sanding and finishing process takes place. Many practitioners advise a longer settling period of 10 - 14 days where possible. This period is also beneficial for curing of adhesives where utilised.

5.2 Preparation

5.2.1. Punching Nails

Before the sanding process can begin, ensure that all nails are punched a minimum of 3 mm below the surface of the boards. Any nail, which is not suitably punched, will potentially damage the sanding equipment. It is important to note that secret nailed boards may well have been top nailed adjacent to a wall or other areas where access is limited.

The punched nail holes can then be filled with either an oil based or non-oil based filler. Oil based fillers may tend to bleed oil into the timber affecting the colour of the wood around the nail hole or may not be compatible with various coating products. The colour of the filler should be carefully selected in order to minimise any visual impact of the filler. Many of these products are sold in colours pre-matched to specific species. In materials with a large range of colours or in mixed species floors, it is typical practice to mix or select a neutral colour which is a mid range between the extremes of colour preferably hedging on the slightly darker side of mid range to allow the boards to deepen in colour following the coating application and UV exposure.

***NOTE**: Filling can be done at this stage or after the first coat of finish is applied. By filling after the first coat any potential for the filler impacting on the surrounding timber through bleed or moisture is minimised. In all cases the filler must completely fill the hole without any "pocketing" or hollows within the filler that could impact on the finish quality.*

5.2.2. Cleaning

Additionally, the floor should be thoroughly cleaned and free from dirt, grit and debris. These particles if not removed can cause deep, uneven scratching in the timber surface requiring substantial additional sanding to remove. The floor should initially be swept followed by vacuuming the area paying particular attention to areas which are not effectively cleaned by sweeping such as gaps underneath the skirting, corners, window sill and the like. The vacuum should have sufficient capacity in terms of both suction and filtration to satisfactorily clean the floor.

It is important to remove any materials, which may potentially impact on either the sanding or coating process. Additional care should be taken with silicone-based sealants, which may have been dropped onto the floor. These products can potentially be widely spread through the sanding process impacting on the bond between the coating and the timber.

5.2.3 Protection

During the sanding and finishing process it is imperative that access to the area of the work be restricted. Any trades working in or around the area can potentially generate dust, wet the floor, introduce silicone based mastics and sealants, walk over the area or generally contaminate the area. Clear instructions should also be given to the owner or occupants regarding access, opening windows which may blow dust over the area and time required for coating systems to adequately cure.

5.3 Sanding

The sanding operation will vary slightly based on both the condition of the floor along with the hardness of the species of flooring. Where the floor is being sanded for the first time, the sanding process is made up of a number of separate sanding stages, which generally start with a course paper and progress to a relatively fine grade of paper. It should be noted that the sanding process is effectively scratching off the surface of the boards, and the reduction in grades of paper means that you start with a severe scratching action and finish with a more subtle scratching action.

Step 1 - Level / Basic Sanding

The level/basic sand, as the name suggests, is to cut the boards level, taking out any ridges or high points in the floor. It typically comprises of three passes with the sanding machine. The level or basic sanding is to provide a level, completely sanded floor - each of the sanding procedures which follow this step are designed to remove the sanding scratches generated by this initial step.

Pass 1 is done from a small angle or up to a 45 degree angle to the direction of the grain (diagonally). This angle is dependant upon the layout and size of the area to be sanded. A 24 - 36 grade of paper is used depending upon the species and the condition of the boards. Ie for a floor, which is very uneven, or with hard species such as Turpentine or Ironbark etc, the lower grade of paper might be utilised to enhance the effectiveness of the sanding process.

Load the drum-sanding machine with the appropriate grade of sand paper. Starting at a point which will allow the longest path of travel at approximately 45 degrees (or as is deemed appropriate given the room parameters) to the grain direction (run of boards) start the machine ensuring that the drum is not touching the boards. Walking slowly forward, the drum is eased onto the boards. Maintain a similar pressure and slow walking pace across the diagonal direction. The drum should be raised smoothly as you reach the extremity of the pass ie where the proximity of the wall or other obstruction limits the access of the machine. Begin to walk backwards, pulling the machine, easing the drum to the floor.

NOTE: *The power lead must be kept well clear of the drum. Ensure that the operator maintains control of the lead to prevent possible accidents.*

When the original starting point is reached gradually raise the drum from the floor. The machine is then moved to the right or left hand side of the first path ensuring an overlap of between 50 - 100 mm onto the first cut path. Continue in that direction of graduation in the same manor sanding strips and maintaining a similar overlap in each forward and back pass. When you have reached the limit of accessibility in the corner of the room, move the machine back to the starting point and begin sanding the remaining floor in the same direction and manor to the opposing side of the first cut - ie if you worked to the left of the first cut then start working on the floor area to the right of that first cut. Ensure that there is an overlap of around 200mm between the two sides of the floor.

Pass 2 is carried out on the opposite diagonal to Pass 1 utilising the 24 - 36 grade.

Pass 3 is carried out in the direction of the boards using either the worn paper from Pass 1 & 2 or a 40 grade of paper. Typically the operator should start at a point, which is a few metres off the side wall. The process of walking speed, easing the drum onto the floor is as per the previous advice.

Once a forward and reversed path is sanded, move the machine across ensuring an overlap of 50 - 100 mm onto the previous pass cut and sand as per the previous path. This process is carried out across the room. When the full width of the room is sanded, the operator should turn around 180 degrees and sand the un-sanded band of floor.

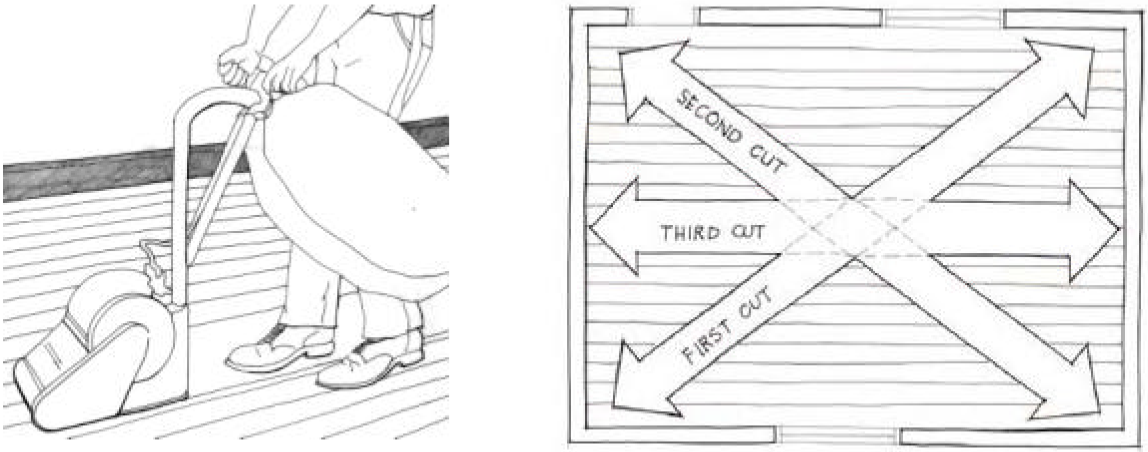


Fig 19 Sanding Patterns

At the completion of the level or basic sanding the boards shall be generally smooth and free from cupping and mismatching of surface levels between adjacent boards. If this has not been achieved the floor will require additional passes to achieve this state.

***NOTE**: Never let the sanding drum contact the floor unless you are moving. Doing so will cut a groove into the floor which may not be recoverable.*

***NOTE**: Specialist equipment and manufacturers recommendations and user instructions should be followed.*

Step 2 - Edging

The sanding machine will not be able to sand the boards along the edges of the room, in corners or areas of reduced access such as wardrobes etc. In these areas the boards need to be sanded level and generally blended into the body of the floor in terms of finish. For these areas an edge sander is utilised. The machine used may vary from either a disc, orbital or belt sander. In all cases, care should be taken so that the operation does not dig grooves into the boards and the overall edge is finished level with the body of the boards. This is often an area, which lets down what would otherwise be an acceptable job.

The most commonly utilised machine for the edging process is the disc sander. When using this machine the operator should move the machine in smooth quarter circle pattern where sanding the ends of the board across the grain. The pattern of sanding should overlap and blend into the body of the sanded floor some 100 - 150 mm. It is important that the machine is held level as the boards are easily grooved with any uneven pressure. On each movement, the machine should sand a 25 - 50 mm section of un-sanded floor. Along walls parallel with the boards, the edge-sanding machine should be smoothly moved back and forth in the direction of the grain (boards) overlapping some 100 mm into the body of the sanded floor.

Grades of paper used on the edging machine are typically as per the sanding machine.

It may be necessary in areas of very limited access or at the corners of the room, to hand scrape the floor. The scraping action should always be in the direction of the grain with the surface being hand sanded or machine sanded with a smaller machine ie orbital sander. Do not apply too much pressure to the orbital or use an overly aggressive grade of paper, as the result may be deep swirl marks, which will show up in the finish. Once again, care needs to be taken to blend in these hand scraped areas with the body of the floor.

This process is repeated following the second sanding process of the body of the floor.

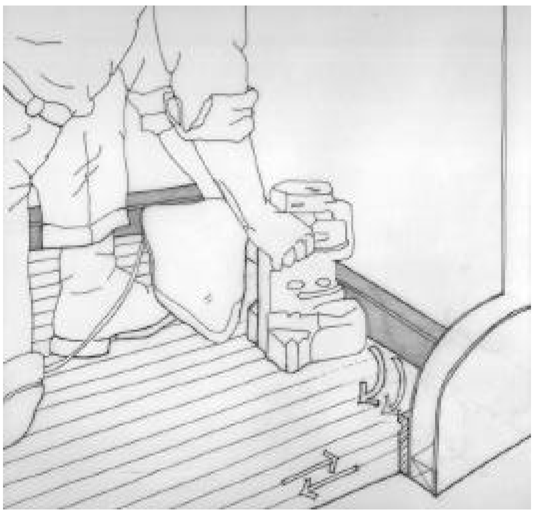


Fig 20 Edge Sanding

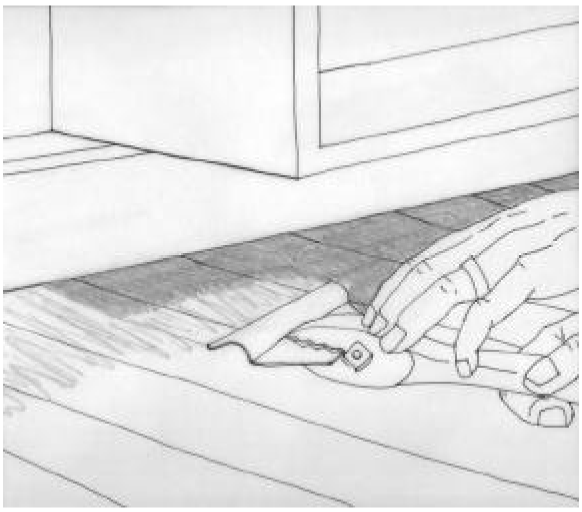


Fig 21 Scraping where access is limited

Step 3 - Finish Sanding

The finish sanding operation involves two separate stages of operation.

Stage 1 - Initial Cuts

The initial cuts utilise a finer grade of paper to that used in the level or basic sanding operation. Typically an F60 - 100 grade paper on the sanding machine run in the direction of the grain (board run). The purpose of the initial cuts is to smooth off the course sanding marks left by the level or basic sanding. Once a suitable level of smoothness is achieved, the final stage of sanding may be carried out.

Stage 2 - Final Sand

The final sand utilises an even finer grade of paper - once again reducing the depth of the scratching and preparing the floor for the coating system. The floor must once again be fully cleaned of dust, grit and debris. Any matter left on the floor will invariably impact upon the quality of the finish.

Typically, the final sand is carried out using a rotary sander, plate orbital sander or similar machine with a 100 - 150 grade paper. The sanding should be carried out in the direction of the grain ensuring a smooth action, and applying a balanced control of the machine. If a water based coating system is specified, the grade of paper needs to be minimum 220 screen back.

Vacuum thoroughly and if required tack rag clean the floor. Pay special attention to any potential dust traps in the floor - dig out any dirt or dust and vacuum away. These can contaminate the floor coating system if not cleaned adequately as the applicator will most certainly pull the dirt onto the body of the floor.

***NOTE**: Heavy sanding equipment may have the potential to create wheel marks on low-density floorboards such as Baltic pine. Additional care should be taken in these applications.*

5.4 Coating The Floor

There are a number of coating systems available on the market. Generally they can be divided into:

5.4.1. Moisture curing polyurethane:

This product otherwise known as single pack polyurethane forms a hardwearing surface. The drying time will vary based on atmospheric conditions. Problems can also occur where application takes place in very dry conditions. The product can also have some edge bonding affect. This problem arises when the coating oozes into the tongue and groove joints between the individual boards. The surface area of this joint is fairly high and the coatings adhesive properties effectively "glue" the boards together. Refer Section 7 for more information.

***NOTE**: Producers of these products are aware of this affect and advice should be sought regarding application methods or pre-finish coats which reduce this propensity.*

5.4.2. Two pack polyurethane:

The coating gives an excellent, hardwearing surface. Some problems may occur with edge bonding. (Refer moisture-curing polyurethane for details) This product is only available in gloss.

5.4.3 Water-based polyurethane:

The coating cures by evaporation and reaction with the water embodied in the sealer. It forms a clear, hardwearing surface. Drying times are relatively short and more than one coat can be applied in a day. It contains no solvents or formaldehyde and is often selected where there is some concerns regarding fumes. Gloss and satin finishes are available however to achieve high levels of gloss requires up to 4 or more coats.

5.4.4 Oleoresinous Oils:

Oleoresinous coating systems are clear varnishes. They are generally made up using a mixture of a resin and an oil (usually a tung oil). They are easy to apply, penetrating and give a slightly softer look as compared with the polyurethanes. The coating drying times are affected by atmospheric conditions and are generally slower than polyurethane. They are less hardwearing than the polyurethane, however any scratches can be readily touched up. A surface polish is recommended to enhance the gloss levels and to protect the coating from scratching. High gloss levels are achieved using a polishing machine and regular maintenance.

5.4.5 Oils:

Oils such as tung oils are a traditional method of coating timber floors. They are a penetrative finish, which is generally less hard wearing than the modified oils or polyurethanes. The coating is slow drying and requires regular coatings with maintenance products. The product gives a very soft and natural appearance.

In all cases it is imperative to closely follow the manufacturers instructions. The following information is a typical application methodology, which might be utilised for the various finish types with minor variations, which are product specific.

5.5. Coating System Application

Step 1 Cleaning

The floor finish will be easily contaminated with any dirt, dust or other extraneous matter left on the floor. It is essential that the area be thoroughly cleaned paying particular attention to any areas, which may have caught dust during the sanding process. Window sills, picture rails, skirtings, power and light switches, light fittings, handrails, etc. Any small cracks in the floor should also be well cleaned out as the applicator will tend to draw these contaminates out in the coating process.

The area needs to be well lit with adequate ventilation. It is important not to have draughts blowing across the floor during the process as they may well introduce contaminates from outside of the actual working area.

Step 2. Mixing the Coating

The coating material should be well and thoroughly mixed so that all the solids are blended through the body of the liquid. Care should be taken not to stir too quickly or roughly as this may introduce air bubbles to the material impacting on the coating quality. If there are any additives to be used, ensure they are mixed thoroughly into the coating liquid.

***NOTE**: In all cases follow the manufacturers instructions.*

Step 3. Cutting In

Using a clean, good quality brush, cut in the finish around the perimeter walls and any other obstructions or areas, which may not be accessible to the main applicator. The cutting in should extend out approximately 150 mm into the body of the floor so that the applicator is not required to venture too close to the skirtings and other limited access areas. If any bristles fall out of the brush into the finish, remove immediately.

Step 4. Applying the Coating

There are many approach and methods utilised in the application of floor finishes and coating systems. The following approach is one such application method, which has generally been accepted by the industry.

Using an applicator as specified by the manufacturer of the coating system (a 6mm Mohair roller or equivalent is commonly utilised) the applicator is immersed in the liquid and removed, removing any excess dripping material back into the container. A large painters tray is ideal for this situation as it allows the applicator to be lightly squeezed on the shallow portion of the tray. The application of the product on the boards should be carried out in a smooth action starting at one end of the boards and working the product along the full length of the boards. It is important to work on only fairly narrow strips of boards at a time ie 2 - 6 board widths. The finish should be feathered off at the outer edge to minimise any build up of coating at this point. This process should leave a “wet edge” so that each successive section of application blend into the previous strip without any ridging which can result if the material skins or dries off before the next application strip.

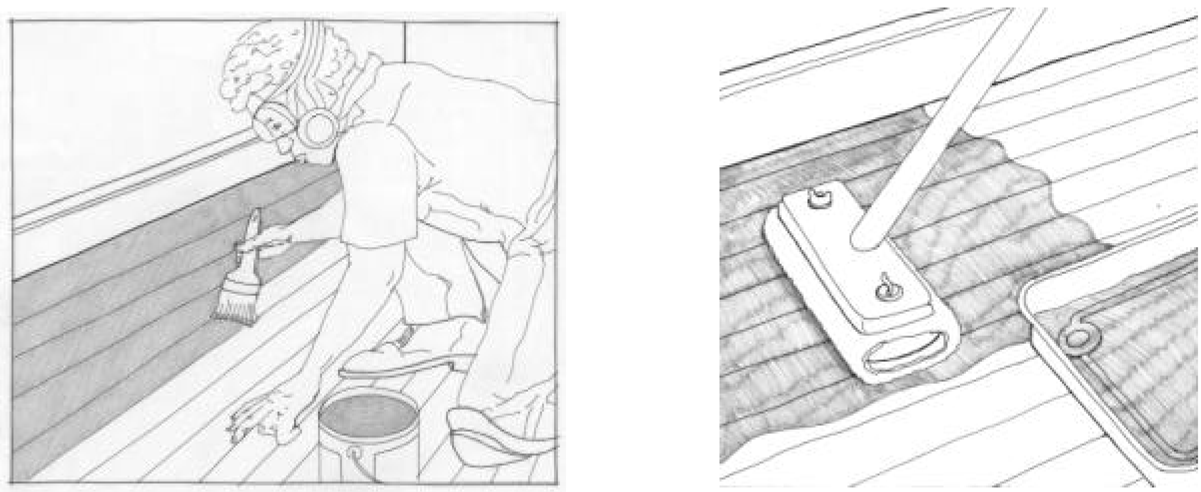


Fig 22 Application Technique

The application process should continue in the same manner working from one end of the boards along their full length until the floor is coated.

An even, wet look should result without any dry patches.

Step 5. Filling / Stopping

The nail holes previously punched and any cracks or other open faults should now be filled with a suitable filling compound, which is compatible with the finish type. (Note Insure the coating system is dry) Generally, a non-oil based filler is best which is suitably colour matched to the timber. In many cases it may be necessary to have two or more fillers of varying colour to blend in with the variety of board colours.

The filler should be installed with a clean bladed applicator. Ensure the filler slightly overfills the hole and has been fully pushed into the void without any hollows. If the material is not completely filling the void, it may potentially come lose in service. Clean off any filler, which is spread over the floor surrounding the hole. Any excess will be sanded away in the light sanding between coats.

Step 6. Sanding Between Coats.

The floor will typically have a slightly rough feel to it after this first coat of finish. The cause of this is generally the raised grain of the timber. The floor requires a light sand after the first coat to remove this roughness and to also key the surface for the next coat of finish. A 150 or finer grit paper or screen back is used at this stage either with a rotary sander or drum sander. It is imperative that the sanding does not expose the timber as this will create further raised grain. The sanding process is required to smooth off the roughness in the coating - not the timber. Edges must be hand or orbital sanded to a similar smoothness.

Step 7. Clean

Once again all the dust should be thoroughly removed from the floor along with any potential dust traps as previously described. Ensure that there are no draughts blowing through the area, which could contaminate the final coat(s). In addition, it may be prudent to use a tack rag over the floor to remove any dust missed by the vacuum. This will ensure that the floor is as clean as possible for the final coat(s).

Step 8. Second Coat

Once again, the floor should be edged with a clean brush coming out some 150 mm or more into the body of the floor.
The application process is as per the first coat with the applicator being worked along the full lengths of the boards and lightly feathered at the outer edge of each strip of application.

Step 9. Additional Coats

Any additional coats shall follow the same process of light sanding of the previous coat, thorough cleaning and application of the coating. Typically a three coat system is utilised however all manufacturer's recommendations should be followed in regards to number of coats and sand paper grades in addition to any requirements by the specifier. Various water based coating systems require a finer grit of paper between coats as compared to the oil or solvent-based products.

Acceptable Finish

The finish should be uniform in sheen levels without any dry or "rough" patches. Deep scratch marks should not be present. As the sanding and finishing process is a series of diminishing coarseness in paper grades it may be assumed that very light scratch marks may be visible under close scrutiny and very severe lighting conditions. It should be kept in mind that the floor will be at its most exposed and under its closest scrutiny following the last coat and before furniture, rugs etc are installed into the room(s). Within reason, very minor blemishes should not impact upon the performance and aesthetics of the floor.

SECTION 6 PROBLEM SOLVING

6.1 Introduction

This section deals with common problems experienced on flooring projects, detailing the problem, probable causes and steps to rectify. In most cases, problems with timber floors are related to moisture. More specifically, it is changes in atmospheric or service conditions, which generate these changes in moisture content of the boards. These MC changes can be due to weather condition, ie there is an extended period of exceptionally dry or wet weather. Perhaps the boards were acclimatised during a period of these exceptionally dry or wet weather and may tend to take up or expel moisture when the weather returns to a more typical set of conditions prevails. Perhaps there is a leak into the sub-floor area either from a pressured water pipe or a stormwater line. Perhaps the ventilation for the sub-floor is blocked or inadequate to cope with prevailing conditions. Air-conditioning may be impacting upon the floor. Perhaps the floor was acclimatised with the air conditioning in operation, and during periods of mild weather, the air conditioning is turned off - increasing the humidity level in the room and thus increasing the MC of the boards. Perhaps the slab heating is similarly not in operation. All these issues plus a number of other variables will impact on the moisture content of the floorboards.

In many cases, the problems encountered with timber floors could have been avoided with good building practice. Site assessment covering the issues of sub-floor ventilation, concrete slab moisture, stormwater, wet trades and scheduling and operation of services and acclimatisation if necessary, cover the basic impacting forces upon the timber. It is also good building practice to document the findings of the site assessment.

6.2 Gapped Boards.

Floorboards will always move slightly during the various weather patterns in the service life of the floor. Slight gapping during extended period of dry weather is not uncommon, however if the gapping is excessive or has occurred during fairly typical weather conditions it is an indication of the boards having been installed at an excessive MC for the location or the service conditions have changed.

Changes in service conditions could be:

Extended period of dry weather.

Air-conditioning - new or in operation after the boards were installed.

Slab - heating - boards not acclimatised with the slab heating in operation.

Sub-floor ventilation - increased.

Site drainage improved.

A thorough inspection of the house is required ensuring all the above issues are discussed with the tenants or builder. Without re-introducing an increase in humidity, the boards will not close up these gaps. If the problem is related to the general prevailing weather conditions (ie they are extremely dry) - the boards should return to a closed state once the weather returns to a more typical set of conditions.

Localised gapping (ie only occurring in selective areas will be due to specific environmental conditions affecting that area only) (ie areas around heaters, exposed windows, fridge air outlets, etc). All these areas will have slightly drier conditions than the general room or sub-floor atmosphere and may cause some localised gapping.

6.3 Clumping / Edge Bonding

Clumping is a term used where the boards have gapped unevenly across the floor. Rather than having a small gap between each board, there will be a group of boards without gaps between them, then a large gap and then another group of tight boards. The problem is initially caused by a reduction in the moisture content of the boards, which is exacerbated by the coating system bonding the boards together and thus not allowing the boards to separate. The finish seeps between the boards on initial application, and on drying securely glues the boards together. The forces involved in the shrinkage will then open up a large gap every 4-6 board widths. In some cases, the bond may be stronger than a particular board, which might split the board.

The problem of the clumping cannot be resolved, the edge bond, once established is permanent. Many of the manufacturers of coating systems which have this gluing effect, have developed a product which is applied over the boards before the first coat of finish is applied to effectively act as a bond breaker. Seek advice from the manufacturer or distributor of the product regarding application advice and precautions.

The changes in service conditions and inspection requirements are as per gapped boards.

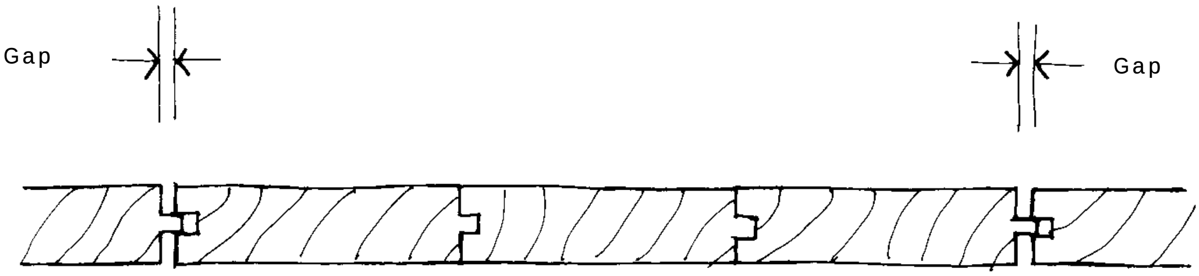


Fig 23 Edge Bonding / Clumping

6.4 Cupping

Cupping occurs when there is a moisture variance or imbalance through the thickness of the board. The boards' width is increased in the lower section forcing the upper edges up and leaving a "cup" in the centre of each board. It is an obvious sign of a moisture problem in either the substrate ie the concrete slab to which the floor is fixed, or a damp sub-floor area. It can also occur where the floor has been flooded with water and the top surface of the board dries out or absorbs less water than the lower portion of the board. This scenario is common in installations over a concrete slab and any continuous substrate such as plywood or particleboard. Another common scenario is where boards are heavily exposed to sunlight (eg a sunroom) compounded with restricted airflow to the bottom surface.

The solution is to initially resolve the source of moisture. In the case of a floor over a slab or other continuous substrate, the test results regarding the slab moisture content should be sought. If the slab was essentially dry at the time of laying the question is;

a. Has the slab increased its moisture content through plumbing leaks or an inefficient vapour barrier?
b. Has water been introduced through an open window, spillage etc?
c. Has the room environment experienced long term drier conditions?
d. Has the floor surface been dried on the top surface (ie sun exposure)?

It is important to narrow the source of the problem down for a long-term result. The once off spillage or flooding should be dealt with by simply allowing the floor to dry and stabilise over a period of time. A source of moisture through a leaking pipe needs to be rectified urgently by a qualified trades person. The vapour barrier is not so readily repaired and will cause on-going problems with a timber floor. Typically, improvements to the subsoil drainage will lessen the propensity for water migration.

Care should be taken that the boards not be sanded in this cupped state. If they are sanded before the source of moisture is resolved and the floor stabilised, then when the bottom of the board does dry the finished surface will tend to have a series of convex curves called crowning, with V grooves between each board where the previously cupped edges were sanded off.

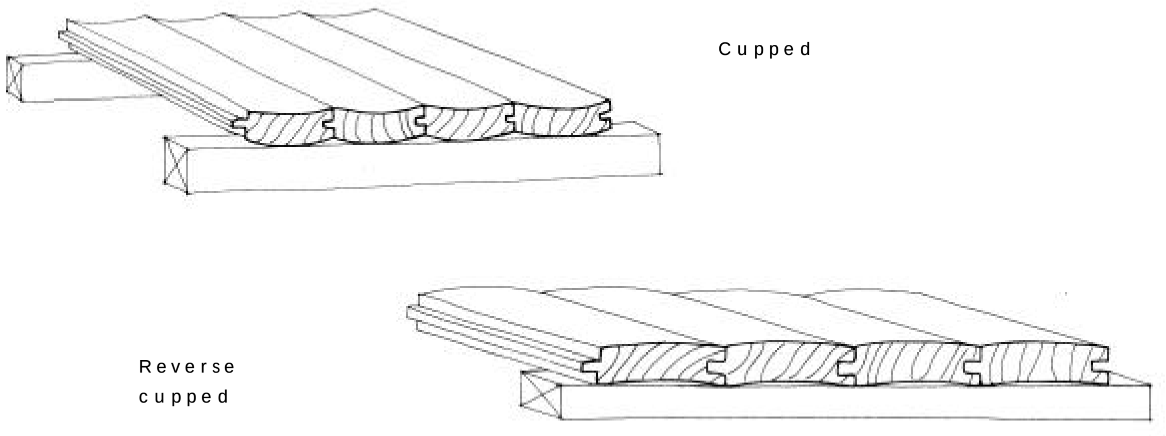


Fig 24 Cupped Boards

6.5 Impacting on Structure

Where a timber floor has been installed without adequate expansion joints and is subject to an increase in moisture content, the boards' growth in overall width may impact upon the structure of the building. This may include either impacting directly on walls or other vertical barriers or bowing the floor joists off the bearer or a combination of both.

In all cases the serious nature of the problem should not be under stated and immediate action should be taken to both remedy the immediate problem of structural impact and to also uncover the source of the problem.

The most common source of the problem is sub-floor moisture combined in many cases with inadequate sub-floor ventilation. The moisture problem maybe related to a pre-existing source such as inadequate stormwater and site drainage, or alternately a leaking water pipe. These problems must be fixed as a matter of urgency to minimise any potential damage.

NOTE: *Where there has been a large increase in the moisture content of the timber, the standard 10mm minimum sized expansion gap along the walls and against any other vertical barrier may not be adequate.*

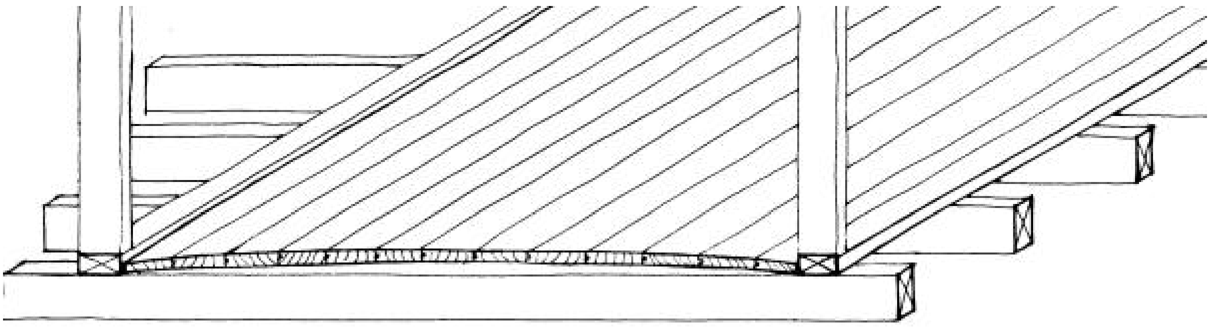


Fig 25 Expansion Impact On Structure

To relieve the pressure from the floor, it may be necessary to remove a board or at least cut out a small section of board along the walls parallel with the run of the boards. As there is quite a bit of pressure involved, a conventional saw will tend to bind between the boards. A small chainsaw or circular saw is commonly utilised as they have a self-clearing blades.

Where there is adequate ventilation and potentially little improvement achievable with the stormwater system, a layer of building plastic can be placed over the surface of the ground in the sub-floor area. The joints should be lapped and tapped and where required a ballast of sand or other material installed such that water does not pond. This limits some of the moisture vapour from penetrating into the sub-floor region, thus reducing the deterious affect upon the timber. This method should not be used as an addition to the actual control of the moisture problem where possible.

APPENDIX A – CLIMATE ZONES

Climatic Zone	Recommended Average Moisture Content on Installation
Costal (Zone 3)	12%
Inland Zone 1 & 2)	9%
Air Conditioned	9%

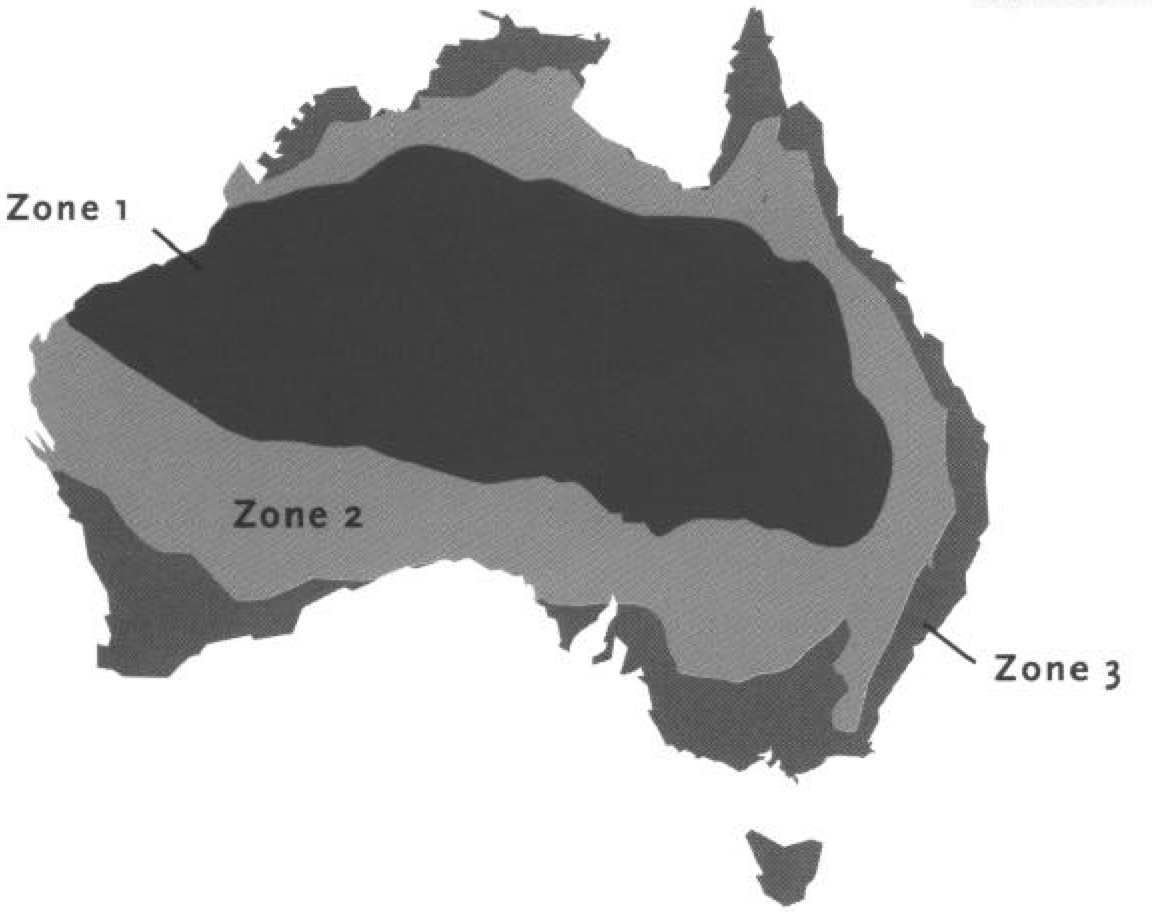


Fig A1 Australian Climate Zones

APPENDIX B - TESTING A SLAB FOR MOISTURE CONTENT

Glass or Rubber Test

Testing for moisture in a slab can initially be carried via a simple test; placing and sealing a small section of impermeable material (glass, rubber etc) to the slab surface. The basic idea is that if the slab has a high moisture content, moisture will condense under the impermeable material. The testing material dimensions should be 300 x 300mm if glass or of not less than 600 x 600mm if made of either rubber, plastic or other suitable alternative. It should be left fully sealed in position for not less than 24 hours. The sealing compound should not be water based as this will impact on the result. Plasticine is commonly used. On removal, the surface area of the slab directly under the sheet should be inspected for any surface wetting which could either be water droplets if the slab has an extremely high moisture content or a slight darkening of the surface compared with the surrounding slab surface. If any signs of moisture are evident, the slab is unsuitable for timber flooring without taking added precautions. It should be noted that this form of testing cannot be solely relied upon for giving accurate moisture content results.

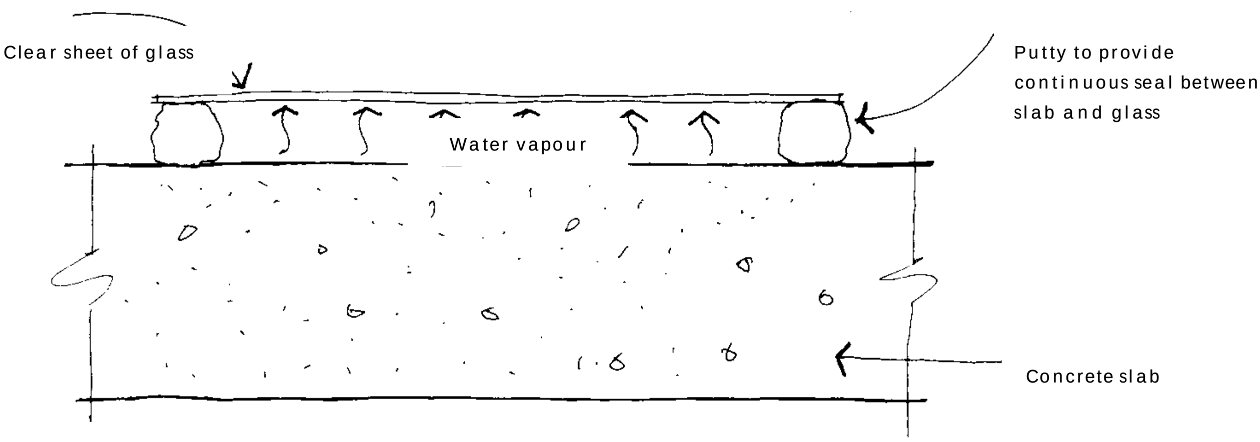


Fig B1 Glass Test

Electrical Resistance Test

This form of testing gives a far more accurate result and is the most commonly utilised testing procedure. The apparatus consists of a resistance meter of suitable range to enable it to be calibrated for a moisture content range of 4-9 % with sufficient sensitivity to clearly distinguish variations of 0.5%. Attached to the resistance meter are suitable electrodes for insertion into holes drilled into the slab and filled with a conductive jelly.

The procedure is to drill the holes to approximately 25mm in depth of a suitable diameter for the electrodes - typically a 6mm hole - and at a spacing in line with the manufacturers recommendations. Fill the holes with the conductive jelly followed by inserting the electrodes. The electrodes must be left in the hole for a minimum of 30 seconds. Connect the electrodes to the resistance meter and read the moisture content to the nearest 0.5% making allowance for the slab temperature.

The test should be conducted along all external walls at intervals of no more than 3 metres, in corners (approximately 1m from the corner), adjacent to all columns and in any areas of increased slab thickness as advised by the builder.

At least three test positions should be chosen for a timber floor of 15m2 or less with an additional one test per 10m2 - 20m2 of floor area.

Precautions

Where the slab contains plumbing pipes, electrical conduits or heating elements, great care should be taken when drilling the holes. In these situations the surface hygrometer test could be the safer alternative.

Surface Hygrometer Test

The surface hygrometer works by sealing a small quantity of air between the slab and the instrument. Over a specified minimum period of time trapped air is allowed to reach equilibrium with the moisture vapour released from the slab surface. The relative humidity of the trapped air is then measured giving an indication of the slab moisture content. The testing system is not widely used by the industry with concerns regarding testing time and accuracy of results.

The basic procedure is as follows.

(a) Seal the instrument to the slab surface. The sealing compound should be of a moisture free type. Plasticine is often used for this purpose.

(b) Allow a period of at least 16 hours enabling the entrapped air to reach moisture equilibrium with the concrete base.

(c) Read the moisture content to the nearest 1% relative humidity and adjust for the temperature.

(d) Repeat the above steps in the locations as noted under the resistance testing procedures.

Caution *- Curing compounds and surface sealants may alter the results achieved with any non-penetrative testing method.*

Suitability of Moisture Test Results

The concrete flooring base shall not be considered sufficiently dry if the flooring concrete base exceeds the following results.

(a) 5.5% as determined by the electrical resistance test corrected for the temperature of the slab.

(b) 70% relative humidity as determined by the surface hygrometer test.

Where the slab's moisture reading is higher than the results specified above, the concrete may potentially create adverse conditions for the timber, potentially causing expansion. Where possible, the floor should not be installed until the slab has achieved the desired level of moisture content. Where this is not possible either for unresolved moisture problems or simply that the floor is required urgently, additional measures must be taken to ensure satisfactory results.

Sealing the slab with a suitable waterproofing compound is one such acceptable approach. Care must be taken to follow the manufacturer's requirements and to minimise any penetrations through the membrane. Where the moisture content is high there exists a potential for a hydraulic head of pressure, which must be resisted by the membrane. In such cases, a timber floor would not be a suitable finish given the potential for ongoing problems.

Where the moisture content is marginally above the recommended limits, the preferred practice is to install a polyethylene (200 micron minimum thickness) or other suitable plastic membrane lapped a minimum of 200 mm and taped over the surface of the slab. The taping of the lapped joints should seal the joint thoroughly. The edges should be turned up, at a minimum, to a level in line with the upper surface of the boards. Once again, care must be taken to avoid or minimise any penetrations through the membrane. The battens or plywood underlay are installed over the membrane and fixed in the conventional manner as described in Section 5.

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