

This information sheet is an extract from ATFA's industry standard - Solid Timber Flooring (2016).



3 Site sanded T&G floor installation:

Timber & sheet subfloors

3.1 Installation practice and products

This section outlines the recommended practices for laying site sanded and coated timber strip floors over timber and engineered timber joists (it does not include steel joists), structural sub-floors such as plywood and particleboard and over concrete but does not include direct adhesive fix to slabs which is provided for in Section 4. The fixing of parquet is covered in section 5 and prefinished timber strip floors is covered in section 6.

The process of laying a timber floor is a three-step process that firstly requires assessment of the product being laid, secondly assessment of the expected in-service environment and thirdly, laying the floor by an appropriate method based on what was determined in steps one and two. Aspects needing to be considered with steps 1 and 2 are provided for in section 2. When laying a timber strip floors over joists, either directly on the joists or on sheet flooring fixed to joists, adequate sub-floor ventilation is essential for the satisfactory performance of the floor. Sub-floor ventilation recommendations, as outlined in section 2, need to be adhered to.

The specified recommendations contained in this standard are generic in nature and although frequently used, installers with knowledge and experience in a particular locality (or due to other constraints) may fix a floor in a manner that differs from that outlined here. However, it needs to be recognised that such systems are non-standard, and the installation becomes the floor installers' system rather than an industry recognised system. Due to this the ATFA may not be able to comment on the adequacy of such systems. It is expected that all floor installations will be provided with a robust fixing method and guidance on this can be obtained from the recognised methods outlined in this standard. When site sanded and coated floors are installed with due provision for movement (expansion allowance and acclimatisation as applicable) it is expected that a floor will be provided that is adequately fixed and without severe board shrinkage or severe expansion related concerns. As such a final appearance complying with the provisions of Section 8 – Site sanded and coated floor appearance expectations, should be achievable and expected.

There are also an increasing number of flooring manufacturers who are producing specific products with accompanying installation instructions and such instructions should be strictly followed as they take precedence over the generic methods outlined in this standard. Such instructions often relate to wider thin overlay boards and standard profile flooring for secret fixing. Other manufacturers recommend that standard profile flooring should not be secretly fixed. If flooring is fixed contrary to the manufacturer's intention for the product then it may also affect possible warranty claims. It should be recognised that specific manufacturing methods may apply to certain products and other similar looking products of different manufacture may not perform equivalently even with the same fixing method.

3.2 Consideration of installation methods

Due to climatic differences occurring between and throughout each state and in New Zealand, the fixing requirements of the floor need to be carefully assessed and will differ depending on locality. Due to this, applicable fixing requirements differ to some degree across these regions and between locations within each region or within a state in Australia.

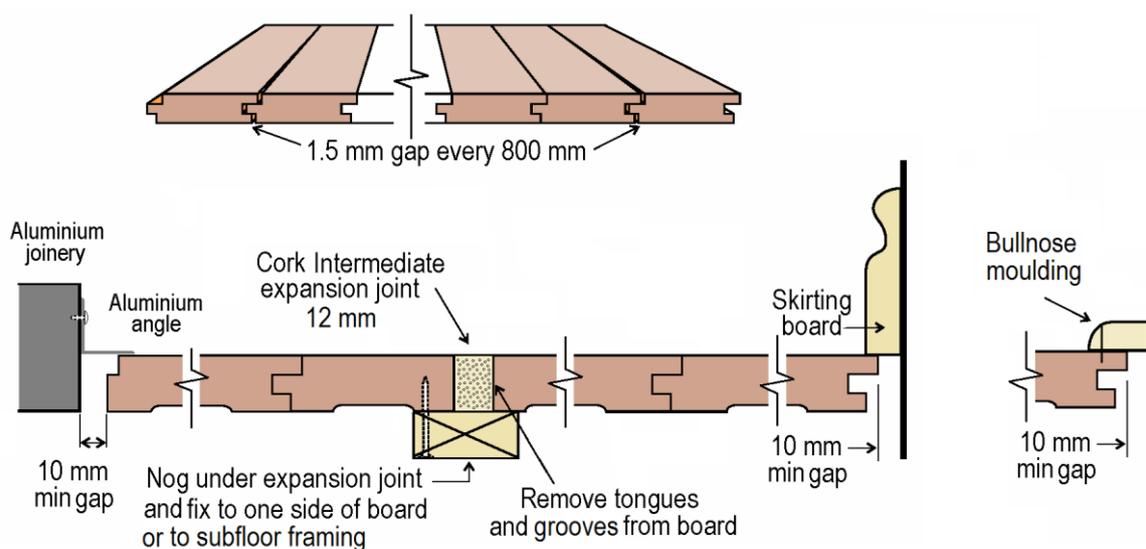
Top (face) nailing is a more robust fixing method than floors secretly fixed with beads of adhesive. Top (face) nailed floors can therefore accommodate greater movement and expansion pressure without buckling. Increasing the amount of adhesive used will also provide more robust fixing and some installers elect to bond the floor with a full bed of adhesive. Where greater floor expansion is expected after installation, the method of fixing chosen and associated spacing of fixings or amount of adhesive used requires consideration. With higher density timbers a full bed of adhesive in humid localities will limit floor expansion but can also contribute to higher pressure at board edges making the floor more prone to peaking, resulting in a cupped appearance (refer to Appendix A7 – Troubleshooting Guide for explanation of terms).

The installation methods covered by this standard are used extensively by many installers throughout Australia and form the basis for the industry's recommendations.

3.3 Allowance for expansion

Site sanded and coated floors require a minimum 10 mm expansion gap between the floor boards and any internal or external wall structures. However, where board ends abut doorways, the gap may be reduced to a neat fit but with a small gap (approximately 1 mm) to prevent rubbing. Where skirtings may only be 10mm wide the wall board can be undercut, or skirting may need to be replaced.

For floors on joists, battens and over sheet subfloors where beads of adhesive have been used as part of the fixing method, floors up to 6 m wide (measured at right angles to the run of boards) are not required to have intermediate expansion joints, provided that it is a normal in-service environment (refer to figure in section 2.6). For floor widths over 6 m in width or where extra allowance for expansion is required (e.g. moist locations) an intermediate expansion joint, a series of smaller expansion gaps often every 800 mm to 1000 mm to provide equivalent spacing, or a combination of both is required. If 12mm wide cork expansion joints are used, the cork should be 2 mm or so proud of the floor surface when installed. This excess will be removed during the sanding process. However, cork to the perimeter should be installed level with the timber surface. It should be noted that cork to aluminum door joinery can cause the joinery to bow under floor expansion and an aluminum angle (as shown in the diagram below) overcomes this. This angle may also be inverted and adhesive fixed to the aluminum joinery or alternatively a small timber bullnose molding, flat fixed to the flooring.





Particularly for wide floors or in moist climates small regular gaps can be used to provide the additional expansion allowance needed. These often close during humid periods.



Cork intermediate expansion joints blend in well with timber floors.

With floor installations utilizing a full bed of adhesive, it needs to be considered that the adhesive fixing substantially reduces the degree of expansion in the floor and that expansion forces have to be resisted by the subfloor. Full bed adhesive fixed floors should be provided with a minimum 10 mm expansion gap between the floor boards and any internal or external wall structures and similarly where board ends abut doorways, the gap may be reduced to a neat fit but with a small gap (approximately 1 mm) to prevent rubbing. The need for intermediate expansion allowance in wider floors will vary depending on the density of the timber species being laid. With medium density hardwoods (e.g. Tasmanian Oak) and floor widths over 6 m or where extra allowance for expansion is required (e.g. moist locations) a 12mm wide cork intermediate expansion joint or a series of smaller expansion gaps to provide equivalent spacing, or a combination of both is required. With higher density flooring (e.g. Blackbutt), board edges do not crush on floor expansion to the degree that occurs with medium density hardwoods. Due to this and the restraining effect of the adhesive, a single cork joint may not provide sufficient movement allowance. In such installations it becomes increasingly important to have the flooring laid close to the expected average in-service moisture content and regular small gaps often provide a better solution.

Also when laying over a structural sub-floor such as plywood or particleboard and the flooring is of higher density, it is important that the subfloor fixing is adequate. In moderately humid locations it has been found that nail and adhesive fixed sheet flooring has in some instances buckled off the joists, even when fixed in accordance with the relevant nailing requirements of Australian standards. Screw fixing to the joists (also often used) provides for a more robust fixing.



Buckling of the plywood subfloor off the joists.

3.4 General Floor Laying Practice

The moisture content, cover width and profile (undercut and T&G tolerance) of the flooring should be checked and preferably recorded (Section 2 – Pre-installation assessment) prior to laying. If it is identified that the moisture content is not correct or the boards are outside of expected requirements, or are otherwise not considered to meet the specified grade, the installer should contact the supplier to resolve these issues before commencing laying. Similarly, any board found during laying that is considered outside the grade specification should not be laid.

Top (face) nailing where used is to be undertaken uniformly with respect to edge distances and alignment across the floor. Some variation due to batten and joist layout may occur.

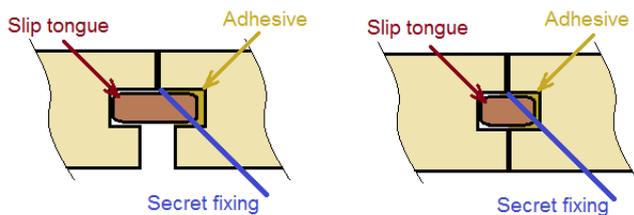
When laying over sheet flooring or an existing floor, boards should be staggered to provide the look of a floor similar to that laid over joists. It is good practice to ensure that end joints are at least 300 - 450 mm apart and that joints do not cluster together or align. For aesthetic reasons close alignment of end joints in adjacent boards should generally be avoided.

Installers also need to consider how the boards will be distributed in the floor in terms of length, grade, feature and colour, irrespective of whether this is on joists or other sub-floors. As such it may be necessary to lay from more than one pack at a time so that the colour range and grade features can be blended through the floor. Care is also necessary that single boards of highly contrasting appearance are not installed in highly visible locations as although not necessarily requiring remedial work, it is not seen as good practice.

With some installations it can be beneficial to reverse the laying direction, and this can be achieved by installing a row of boards 'back to back' with a slip (or false) tongue.

When only moderate expansion pressure is expected in the floor or the flooring is not of high-density species, the slip tongue is glued (with PVA adhesive) into the groove of the fixed board that is fully adhesive fixed to the subfloor, thereby creating a board with a tongue along both edges. The board with the false tongue can then be secretly fixed through the false tongue noting that the tongue needs to be supported while fixing (usually with an offcut) so that the tongue does not drop. The adjoining board should also be fully adhesive fixed to the subfloor and with timber and sheet subfloors also top nailed into them. In instances where greater expansion pressure is expected, or a secretly fixed installation is required, some will trim the top shoulders of the adjoining boards to be in line with the bottom shoulders. Again, both boards need to be fully adhesive fixed, the slip tongue glued into the groove of the fixed board and secretly fixed through the false tongue. With this second option boards widths will be a little narrower. Note that a slip tongue is more appropriate to flooring at least 19mm thick and, with overlay flooring, a double tongue board is sometimes used.

If a slip tongue is not used and boards are not fixed in this manner then, with floor expansion, the floor may tent at this location. The diagram shows the slip tongue methods described and the photo illustrates the consequence of not using a slip tongue.



The photo shows possible consequences of not using a slip tongue and not fixing these boards correctly.



3.5 Installation direct to joists

3.5.1 Construction method

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

3.5.2 Subfloor framing - Bearer size, floor joist size and flooring spans

The size of timber members used to support the flooring boards can be determined from AS 1684 - Residential timber-framed construction and in New Zealand NZS 3604 – Timber-framed buildings. For end-matched flooring profiles, joists with a minimum thickness of 35 mm may be used. Where plain end flooring is butt joined at floor joists, 45 mm or 50 mm thick joists are recommended to reduce splitting problems at butt ends.



Timber floors are successfully laid over a range of solid timber and engineered joist systems.

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

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

The joists must be sufficiently flat to accept the timber floor and to provide a finished floor appearance that also appears flat. The allowable span of timber flooring is dependent on the timber species, density, grade, thickness and whether or not the flooring is end matched. The following table gives the acceptable joist spacing and maximum spans for various flooring products when fixed to timber joists. Maximum board span (the distance between where the timber is supported) needs to be considered in installations where flooring is at an angle to the joists, as this increases the board spans.

Allowable Joist Spacing and Maximum Span of Floorboards

Species Group	Grade	Thickness (mm)	Acceptable Species, Grade and Joist Spacing			Maximum Span	
			450 mm	450 mm	600 mm	End matched	Butt joined
			End matched	Butt joined	Butt joined		
Hardwood All hardwood species listed on page 5	AS 2796 Select Grade	19	✓	✓	✓	500 mm	630 mm
	Medium Feature (Standard) & High Feature Grade	19	✓	✓	✗	450 mm	570 mm
Cypress	AS 1810 No. 1	19	✓	✓	✗	410 mm	510 mm
	No. 2	20	✓	✓	✗	410 mm	510 mm
Softwood	AS 4785 Slash Pine	19	✓	✓	✗	410 mm	510 mm
	Other pinus species	19	✗	✓	✗	350 mm	470 mm
	Araucaria (Hoop Pine)	20	✓	✓	✗	410 mm	510 mm

3.5.3 Installation direct to joists

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



Cramping should be sufficient to just bring the edges of adjoining boards together.

as this type of nailing cannot be relied on to pull the board down to the joist.

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

3.5.4 Top (face) nail and secret fixing direct to joists

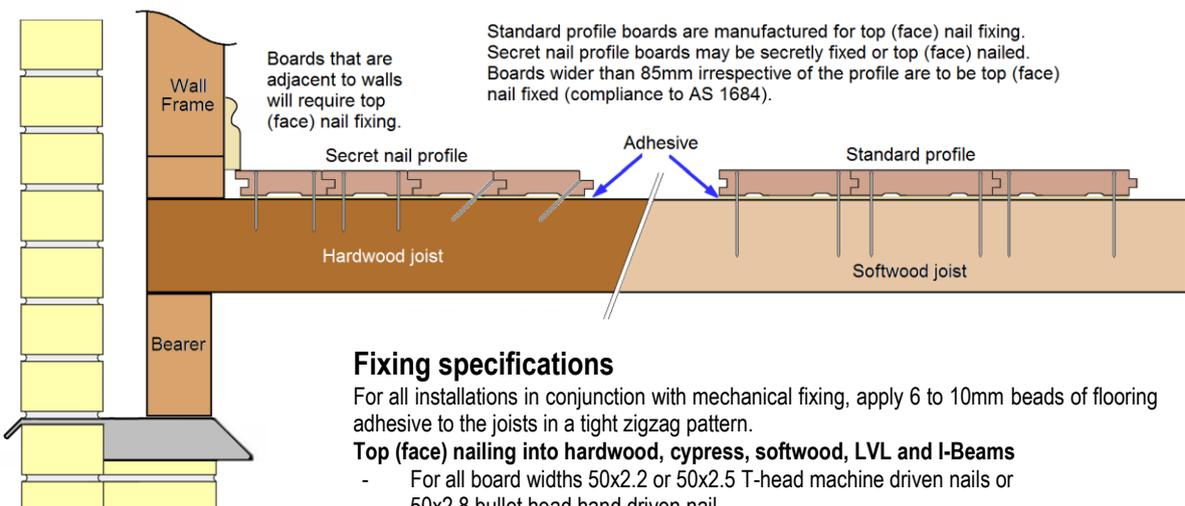
Boards for top (face) nailing and cover widths up to 65 mm are top (face) nailed with one or two nails at each joist. Boards for top (face) nailing and a cover width over 65 mm and up to 135 mm wide should be top (face) nailed with two nails at each joist. Boards wider than 135mm are often top (face) nailed with two or three nails.

Top (face) nailing is to be undertaken uniformly with respect to edge distances and alignment across the floor. Some variation due to joist layout may occur. Boards for secret fixing up to 85 mm wide can be secretly fixed with a staple or cleat at each joist and require a good coverage of flooring adhesive to the joist. Note that in humid and moist localities, additional care is required to cater for possible greater expansion. Consideration should be given to board moisture contents, providing for expansion, the species, joist material and fixing method. In some locations top (face) nailing will be the preferred option. Fixing sizes commonly used for 19 mm to 21 mm thick boards are provided in the following table.



Buckling of 80 mm wide Spotted Gum boards secretly fixed to pine joists in a humid locality.

Secret and top (Face) nail fixing structural 19mm thick flooring direct to joists



Fixing specifications

For all installations in conjunction with mechanical fixing, apply 6 to 10mm beads of flooring adhesive to the joists in a tight zigzag pattern.

Top (face) nailing into hardwood, cypress, softwood, LVL and I-Beams

- For all board widths 50x2.2 or 50x2.5 T-head machine driven nails or 50x2.8 bullet head hand driven nail

Secret fixing into hardwood and cypress joists

- For board widths up to 85mm wide only, 45x15 gauge staples or 45x16 gauge cleats

Secret fixing into softwood, LVL and I-Beams

- For board widths up to 85mm wide 50x15 gauge staples or 50x16 gauge cleats

Recommended minimum edge distance for nailing at butt joints or board ends is 12 mm. All nails, including machine nails, should be punched a minimum of 3 mm below the top surface. During fixing, the joint between floor boards and the top surface of floor joists should be checked to ensure that gaps are not present. If gaps are present, nails should be punched to draw boards tightly onto the joists.



It should be checked that boards are tight on the joists. Secret fixing is recommended for boards up to 85 mm in cover width.

3.6 Installation over existing timber and sheet floors on joists

3.6.1 Assessing the Existing Floor

Timber T & G flooring may be laid over an existing T & G floor or sheet floor (plywood or particleboard). Where the existing floor is structurally sound, either overlay flooring (generally up to 14 mm thick) or structural flooring (generally 19 to 21 mm thick) can be laid. Wider 19mm thick boards (130 mm or wider) and thicker boards (to 21mm) are generally top (face) nailed fixed through the sub-floor into the joists. Narrower 19mm thick boards (85mm or less) and overlay flooring is generally secretly fixed into the subfloor. With 19mm or thicker boards either beads or a full bed of flooring adhesive is used in conjunction with the mechanical fixing and with overlay flooring a full bed of adhesive provides for a more stable floor and is recommended.

In instances where there is doubt over the structural adequacy of the existing floor, either:

- Remove the existing floor and use structural flooring laid at 90° to the joists, and fix into the joists; or
- Replace the defective boards or sheets to make the existing floor structurally sound (structural or overlay flooring may then be used); or
- If the existing floor is not made structurally sound, use structural flooring at 90° to the joists and fix through the existing floor and into the joists.

The new boards may be fixed at an angle (other than 90°) to the joists in a) or b) above provided that the thickness of the new boards is appropriate to the increased span between the joists (as a consequence of the angle). Top (face) nails in existing flooring should be re-punched where necessary. The existing floor should be rough sanded to provide an appropriate surface over which the new floor is to be fixed. Adhesives require a clean, structurally sound floor that is free from surface moisture, loose particles and contaminants. This includes removal by sanding of the waxed surface layer of particle board floors. In some instances sheet sub-floors (substrates) can sag between joists and require leveling as the sagging, if not attended to, will show through to the new floor.

It is necessary to check that the existing floor moisture content is appropriate to accept the new floor. The cause of any excess moisture (wetting during construction, leaks, inadequate sub-floor ventilation, etc) needs to be addressed prior to installation of the new floor. Moisture meters are unpredictable in sheet flooring and this may necessitate oven dry moisture content testing. Prior to laying, the new floor should be of similar moisture content (within about 2%) to the existing floor.



Before laying over existing floors the moisture content and structural integrity needs to be assessed.

Squeaking present in an existing T & G floor may be reduced by providing a bead of flooring adhesive to fill any gaps between the underside of flooring and tops of joists (caused by cupping, shrinkage etc). Further reductions may be achieved by fixing a seasoned batten (approximate dimensions 35 x 45 mm or 19 x 60 mm) to the underside of flooring (mid-span between joists) and parallel to the joists, fixed with a full-length bead of flooring adhesive and screwed at approximately 450 to 600 mm intervals to hold the batten in place until the adhesive is set. This, however, requires that there is access to the underside of the floor. Note that squeaks can also occur from sheet subfloor fixings and, at times, the joist fixings, particularly if they are in line with the bearers. Checking for subfloor squeaks prior to laying the T&G floor can prevent concerns from arising later on.

3.6.2 General Installation Recommendations

The secret fixing of boards requires one staple or cleat at the appropriate spacing. For (top) face nailing of boards through the sub-floor and into the joists, two nails per board are required at each fixing for boards exceeding 65 mm cover width.

Note that in humid and moist localities, additional care is required to cater for possible greater expansion. Consideration should be given to board moisture content, providing for expansion, board size, the species and fixing method. In some locations top (face) nailing with 19 mm or thicker boards may be the preferred option or a full bed of adhesive used. Overlay flooring can be more reactive to changes in environmental conditions that may be induced not only by conditions beneath the floor but also by sun exposure through large windows above the floor. For these reasons a full bed of adhesive is recommended. Some manufacturers do not recommend that their 130 x 19 mm or wider boards be secretly fixed and other manufacturers have specific fixing recommendations providing for the secret fixing of wider flooring that should be strictly adhered to.

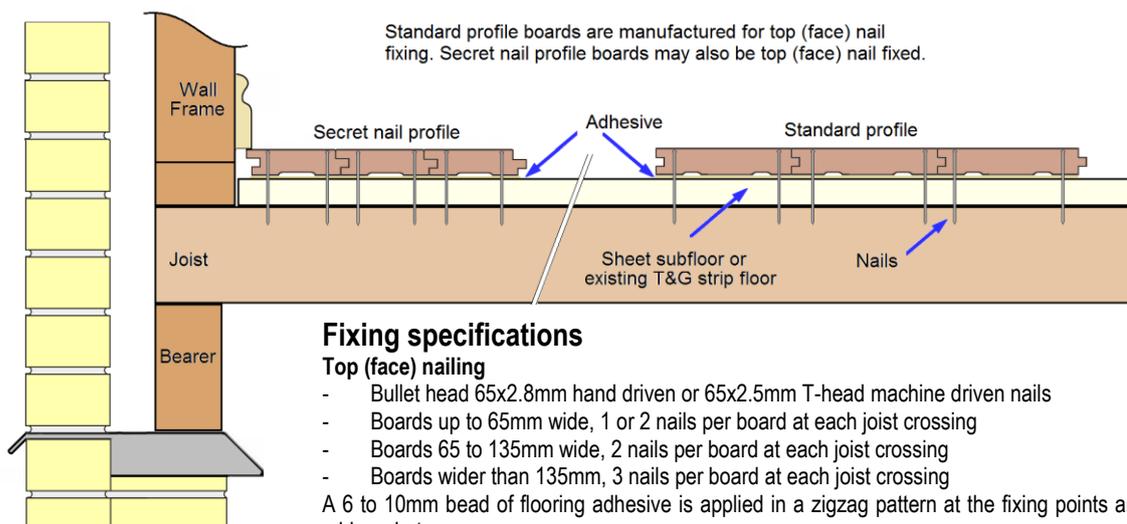
Installation of flooring should not proceed until other construction activities (particularly wet trades) are complete and until after the building is roofed and enclosed. It is also preferable that the temperature and humidity are as close as possible to the expected in-service conditions, although this is often not achievable as heating or cooling systems are generally not operating at the time of floor installation. Additional care, or even delays to the installation, should be considered if weather conditions are extreme for the locality (hot and humid or hot and dry). As detailed above, expansion gaps of 10 mm minimum should be provided at all walls and other fixed obstructions that are parallel to the run of floor boards.

For floors over 6 meters in width or where extra allowance for expansion is required (e.g. moist locations) an intermediate expansion joint, a series of smaller expansion gaps every 800 mm to 1000 mm to provide equivalent spacing, or a combination of both is required. This is particularly so with full bed adhesive fixed floors or floors of higher density species in more humid locations.

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

When structural 19 to 21 mm flooring is used, the flooring can be top (face) nailed through the existing floor or sheet floor and into the joists. Nailing is to be undertaken uniformly with respect to edge distances and alignment across the floor. Some variation due to joist layout may occur.

Top (Face) nail nailing 19mm thick flooring through timber and sheet subfloors into the joists



Fixing specifications

Top (face) nailing

- Bullet head 65x2.8mm hand driven or 65x2.5mm T-head machine driven nails
- Boards up to 65mm wide, 1 or 2 nails per board at each joist crossing
- Boards 65 to 135mm wide, 2 nails per board at each joist crossing
- Boards wider than 135mm, 3 nails per board at each joist crossing

A 6 to 10mm bead of flooring adhesive is applied in a zigzag pattern at the fixing points and midway between.

Board ends adjacent to walls should be adhesive fixed and nailed to the subfloor

3.6.4 Secret Fixing into Sub-floor (Substrate) Only

When relying on the sub-floor or substrate for fixing, boards should be secretly fixed with the first and last few rows of boards that do not allow secret fixing being top (face) nailed. When laying over an existing T&G sub-floor the new flooring may be laid either parallel with or at 90° to the existing boards, or at any other angle to the existing boards providing the sub-floor (substrate) is within the required flatness tolerances and clean for adhesive fixing as outlined above. If there are potential concerns with seasonal movement of a T&G subfloor affecting the appearance of the overlay floor, an underlay may be used. After the subfloor is prepared this can consist of approximately 6mm thick plywood, adhesive and staple fixed to the T&G subfloor. This may be achieved by adhesive beads at 100mm intervals and staples around the perimeter of the sheet, 12mm in from edges and spaced at 75mm intervals and through the main body of the sheets, staple spacing at 100mm. The sheets should be laid in a brick bond pattern with the length of the sheets running at right angles to board length. In New Zealand, underlays are used when fixing over existing T&G subfloors, plywood squares approximately 400 x 400 mm often being used which are full bed adhesive fixed and temporarily screwed until the adhesive cures. With screws removed, a key sand and checking of floor flatness is undertaken. The fixing of the floor may be undertaken relying on a combination of mechanical and adhesive fixing. Some systems rely on mechanical fixing with beads of adhesive while other systems rely on a full trowel spread bed of adhesive for the fixing. Note that with full bed adhesive systems, mechanical fixing is still used to ensure close contact between board and adhesive to result in a strong adhesive bond. In addition to fixings at recommended spacings, fixing is also required within 50 mm of board ends. However, note that if too close, splitting at ends may occur and should be avoided by fixing a little further from the ends.

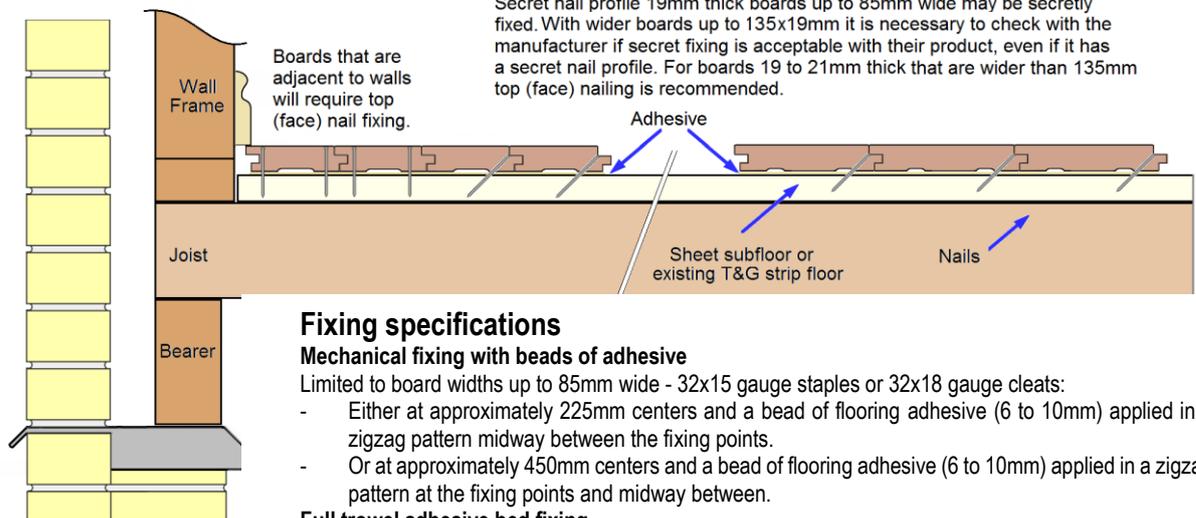
When fixing 19 to 21mm thick boards up to 85 mm wide at close centres of approximately 225 mm, beads of adhesive to provide a cushion between the two floors assists to minimise possible squeaks. This is achieved by using a continuous bead of adhesive at 90° to board length midway between fixing points, or a pattern ensuring there is adhesive to board edges. Where staples or cleats are spaced up to 450 mm apart, beads of adhesive are used at the fixing points and midway between.

With wider 19 mm thick flooring up to 135 mm, a full bed of adhesive with fixings up to 300 mm apart is applicable. Due to the reliance on the adhesive to provide much of the fixing in this instance, it is important that the adhesive manufacturer's recommendations for using the adhesive are followed. Surface cleanliness, flatness provisions and spread rate are all important. Further information on adhesives is provided in Section 4. Note that wider structural flooring up to 135 x 19mm is often required by manufacturers to be top nail fixed and therefore not recommended by them for secret fixing. Top (face) nailing through the subfloor to the joist, therefore, needs to be considered or an alternate product permitting secret fixing of that board width used. With

overlay non-structural flooring, board widths may be up to 180mm and thickness generally between 12 and 14mm. Overlay flooring is adhesive fixed with a full bed of adhesive.

The recommended fixing of the flooring is provided in the diagrams below in conjunction with the fixing specifications.

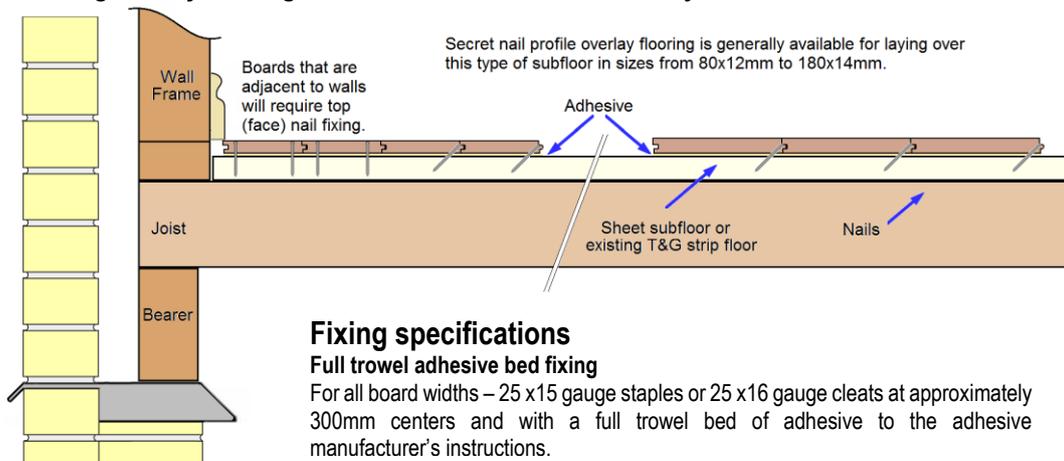
Secret fixing 19mm thick flooring to timber and sheet subfloors on joists



Full trowel adhesive bed fixing

For all board widths up to 135mm - 32x15 gauge staples or 32x16 gauge cleats at approximately 300mm centers and with a full trowel bed of adhesive to the adhesive manufacturer's instructions. Note: suitability for secret fixing boards wider than 85mm is to be checked with the flooring manufacturer.

Secret fixing overlay flooring to timber and sheet subfloors on joists



3.7 Installation over plywood or battens on concrete slabs

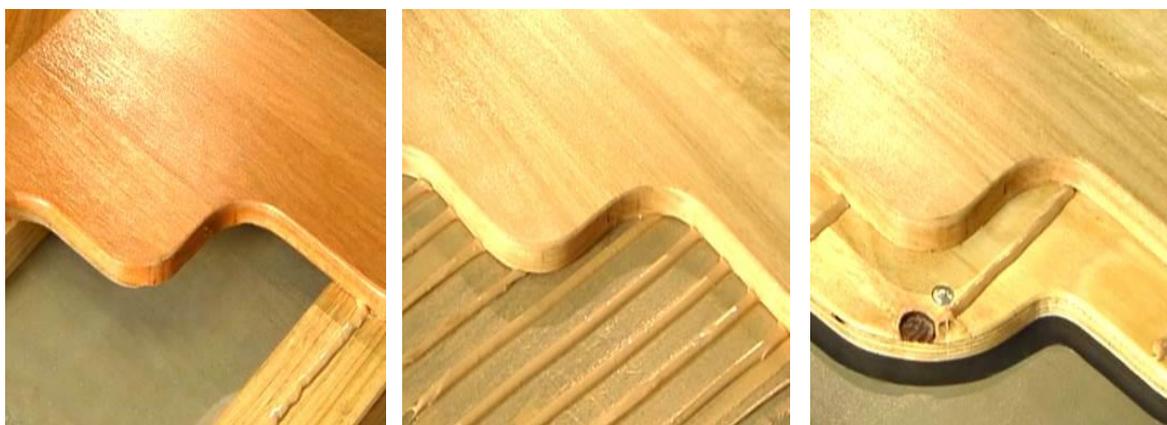
The methods below are generally suitable for structural 19 mm thick flooring with board widths up to 180 mm wide and overlay flooring from 80x12 mm to 180 x 14 mm. Structural flooring is to be used on battens and either structural or overlay flooring may be used on plywood. The secret fixing of boards requires one staple or cleat at the required spacing.

Note that in humid and moist localities, additional care is required to cater for possible greater expansion. Consideration should be given to board moisture content, providing for expansion, board size, the species and fixing method. In some locations top (face) nailing to the battens may be the preferred option or a full bed of adhesive used on plywood subfloors. Overlay flooring can be more reactive to changes in environmental conditions that may be induced not only by conditions beneath the floor but also by sun exposure through large windows above the floor. Some manufacturers do not recommend that their 130 x 19 mm or wider boards be

secretly fixed and other manufacturers have specific fixing recommendations providing for the secret fixing of wider flooring that should be strictly adhered to.

3.7.1 Assessing the Concrete Slab

Timber floors may be laid on battens or plywood over a concrete slab, or by direct fix. Direct fix to the slab (as outlined in Section 4) is a more specialist field and appropriate flooring contractors specialising in this field should be consulted and used if considering this method. The following covers installation of T & G flooring on plywood over concrete or on battens over concrete. Prior to installation it is necessary to ensure that the concrete is sufficiently level to accept the system. Where there is a deviation of more than 3 mm below a 1.5m straight edge or in New Zealand 3 mm below a 3m straight edge, a concrete topping (leveling compound), grinding or packing should be used. Slabs on ground should be constructed with a continuous under slab vapour membrane to applicable AS or NZS standards. Timber floors should not be installed until the concrete slab has been assessed in accordance with Appendix A3. Generally the slab will need to have cured for a period of at least 3 months after the roof and walls are in place and the building enclosed, however if, due to moisture assessments or age of a slab, it is considered to be near ready to accept a floor, applied moisture vapour retarding barriers can provide the necessary protection from slab moisture. This would need to be input from the particular company supplying the product.



Methods to lay timber floors over concrete slabs include battens, direct adhesive fix and over plywood. Direct adhesive fix should be undertaken by professional floor installers.

3.7.2 Installation

With floors fixed over a plywood sub-floor, overlay or structural flooring may be used, but with battens, structural flooring (19 mm or thicker) is required. The plywood sub-floor or battens need to be at a moisture content within about 2% of the flooring to be installed at the time of installation.

Installation of flooring should not proceed until other construction activities (particularly wet trades) are complete and until after the building is roofed and enclosed. It is also preferable that the temperature and humidity are as close as possible to the expected in-service conditions although this is often not achievable as heating or cooling systems are generally not operating at the time of floor installation. Additional care, or even delays to the installation, should be considered if weather conditions are extreme for the locality (hot and humid or hot and dry).



Secret fixing to a plywood sub-floor. A polyethylene moisture barrier has been placed over the slab and both the plywood and flooring are clear of the wall.

For secret fixing to plywood or battens, staples or cleats are used at the required spacing. For top (face) nailing of boards to battens, at each batten crossing one or two nails are required for boards up to 65mm wide, two nails per board are required for boards exceeding 65 mm in width up to 135mm and for boards wider than 135

mm fixed to battens, three nails are required. Nailing is to be undertaken uniformly with respect to edge distances and alignment across the floor.

As detailed above, expansion gaps of 10 mm minimum should be provided at all walls and other fixed obstructions which are parallel to the run of floor boards. For floors over 6 meters in width or where extra allowance for expansion is required (e.g. humid locations) an intermediate expansion joint, a series of smaller expansion gaps every 800 mm to 1000 mm to provide equivalent spacing, or a combination of both is required. This is particularly so with full bed adhesive fixed floors of higher density species in more warm humid locations.

As an added protection against moisture vapour from the slab (from slab edge effects, beam thickening etc.) or minor building leaks, a 0.2 mm thick polyethylene membrane is recommended. The polyethylene should be lapped by 200 mm, taped at the joints and brought up the walls (or fixed columns etc.) to or above the intended top surface of the flooring. The polyethylene is then covered by the skirting. Note that fixings of plywood subfloors or battens through the polyethylene are not considered to reduce the overall effectiveness of the moisture vapour retarding barrier. An applied moisture vapour retarding barrier over the slab may also be used to protect against possible slab moisture (refer to Appendix A3 – Slab Moisture Assessment).

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

In Australia, plywood sub-floors, when hand driven 'spike' fixed to the concrete slab, non-structural CD grade, 15 mm thick and with a type A bond may be used. Plywood 12 mm thick is also used by floor installers but with this thickness greater consideration needs to be given to slab flatness and the possible perforation by fixings of moisture vapour retarding barrier beneath the plywood. Sheets may be installed in a 'brick' pattern or at 45° to the direction of the strip flooring with a minimum 6 mm gap between sheets and a minimum 10 mm gap to internal and external walls. In most cases the plywood is fixed to the concrete. In those cases where for technical or acoustic reasons the plywood cannot be fixed to the concrete, the plywood sheets are laid at 45 degrees to the direction of the floorboards and the end joints of the plywood sheets are staggered. Various methods of fixing the plywood sheets to the concrete are used including adhesives and mechanical fixing. In New Zealand, marine grade structural plywood is generally used and may be mechanically or adhesive fixed to the slab over an applied moisture vapour retarding barrier. Use of polyethylene sheets as a moisture vapour retarding barrier beneath plywood is not practiced in New Zealand.



Fixing of the plywood sub-floor through the polyethylene membrane and into the slab.

The option detailed below is for hand-driven spikes, which has proven to provide solid fixing to the slab:

- Slabs should be flat in that there should not be more than 3 mm below a straight edge spanning between two high points in 1.5 m. If not, the effect needs to be assessed and as appropriate the use of a topping compound prescribed for the purpose or other measures to provide a satisfactory floor installation should be undertaken.
- Install 0.2 mm polyethylene vapour barrier.
- Fix 15 mm thick plywood sheets through the membrane to the slab with hand driven 50 mm long by 6.5 mm spikes ('Powers SPIKE' or equivalent). A minimum of 20 spikes to be used per 2400 mm x 1200 mm sheet, equally spaced (4 rows of 5 spikes down the length of the sheet) and with the outer spikes 75 mm to 100 mm from the sheet edge. If a brick pattern is used, it is preferable that sheets be staggered by 900 mm so that fixings do not line up from sheet to sheet. If



Adhesive spread prior to fixing

12 mm thick plywood is used, 28 fixings similarly spaced (4 rows of 7 spikes down the length of the sheet) should be used.

With regard to floor fixing, some systems rely on mechanical fixing with beads of adhesive while other systems rely on a full trowel spread bed of adhesive for the fixing. Note that with full bed adhesive systems mechanical fixing is still used to ensure close contact between board and adhesive to result in a strong adhesive bond. In addition to fixings at recommended spacings, fixing is also required within 50 mm of board ends, however note that if too close, splitting at ends may occur and should be avoided by fixing a little further from the ends. When laying over the plywood, boards should be secretly fixed with the first and last few rows of boards that do not allow secret fixing being top (face) nailed.

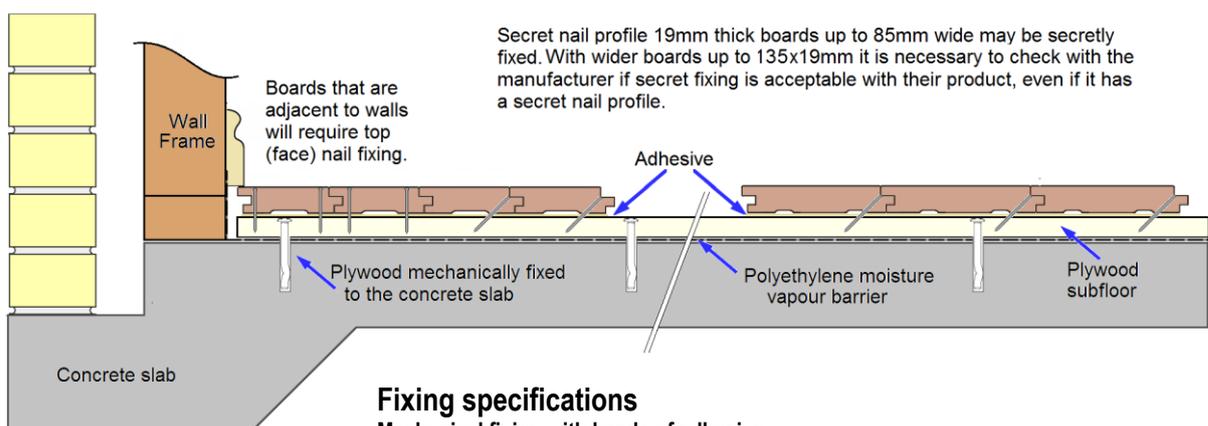
When secret fixing 19 to 21mm thick boards up to 85 mm wide at close centres of approximately 225 mm, beads of adhesive to provide a cushion between the two floors assists to minimise possible squeaks. This is achieved by using a continuous bead of adhesive at 90° to board length midway between fixing points or a pattern ensuring there is adhesive to board edges. Where staples or cleats are spaced up to 450 mm apart, beads of adhesive are used at the fixing points and midway between.

When laying with wider 19 mm thick flooring up to 135 mm, a full bed of adhesive with fixings up to 300 mm apart is applicable. Due to the reliance on the adhesive to provide much of the fixing in this instance, it is important that the adhesive manufacturer's recommendations for using the adhesive are followed. Surface cleanliness, flatness provisions and spread rate are all important. Further information on adhesives is provided in Section 4.

Note that 130 x 19mm and wider structural flooring is often required by manufacturers to be top nail fixed and therefore not recommended by them for secret fixing to plywood subfloors over slabs. Top (face) nailing to battens therefore needs to be considered or an alternate product permitting secret fixing of that board width used. With non-structural overlay flooring, board widths may be up to 180mm and thickness is generally between 12 and 14mm. Overlay flooring is generally adhesive fixed with a full bed of adhesive.

The recommended fixing of the flooring is provided in the diagrams below in conjunction with the fixing specifications.

Secret fixing 19mm thick flooring to plywood subfloor over a concrete slab



Fixing specifications

Mechanical fixing with beads of adhesive

Limited to board widths up to 85mm wide - 32x15 gauge staples or 32x18 gauge cleats:-

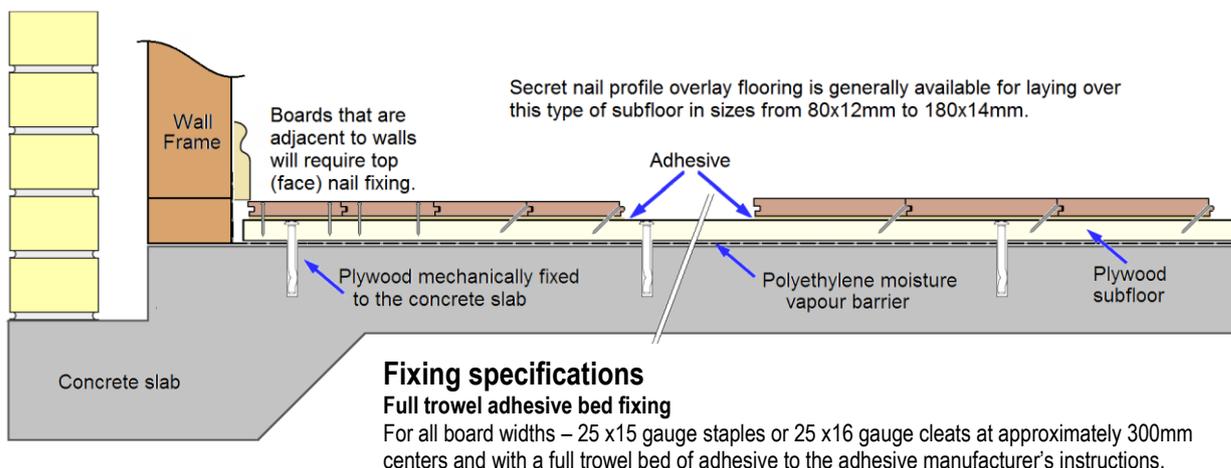
- Either at approximately 225mm centers and a bead of flooring adhesive (6 to 10mm) applied in a zigzag pattern midway between the fixing points.
- Or at approximately 450mm centers and a bead of flooring adhesive (6 to 10mm) applied in a zigzag pattern at the fixing points and midway between.

Full trowel adhesive bed fixing

For all board widths up to 135mm - 32x15 gauge staples or 32x16 gauge cleats at approximately 300mm centers and with a full trowel bed of adhesive to the adhesive manufacturer's instructions.

Note: suitability for secret fixing boards wider than 85mm is to be checked with the flooring manufacturer.

Secret fixing overlay flooring to plywood subfloor over a concrete slab



3.7.4 Fixing recommendations - battens to concrete slabs and flooring to battens

Battens are to be seasoned and may be either hardwood or softwood. Battens may be fixed to the slab using 75 x 6.5 mm gun nails at 600 mm maximum spacing, 'Powers Spike Fasteners' with a minimum embedment of 32 mm or equivalent fastener at 900 mm maximum spacing or M6 masonry anchors at 900 mm maximum spacing. Batten spacing is dependent on the species and grade of timber flooring used and the spacing shall be up to that for flooring being supported by joists, provided above in section 3.5 'Installation direct to joists'. Where higher expansion forces are expected after installation (e.g. warm humid, rural and coastal environments) batten spacing may be reduced to provide more robust fixing and floors that are secretly fixed. If battens are a minimum of 35 mm in thickness, the spacing between fastenings may be increased up to a maximum of 1200 mm provided minimal floor expansion force is expected after installation. Again where higher expansion forces are expected after installation, a maximum fixing spacing of 600 mm is more frequently used with fixing in each adjacent row offset by 300 mm. This is to reduce the risk of the battens lifting off the slab surface under floor expansion resulting in small surface undulations in the floor and more frequent hollow sounds or impact noise.

Structural flooring at least 19 mm thick needs to be used. Boards for secret fixing up to 135 mm wide can be secretly fixed with one staple or cleat at each batten crossing. Note that 130 x 19 mm and wider flooring is often required by manufacturers to be top nail fixed and therefore not recommended by them for secret fixing to battens. Adhesive to the batten with a 6 to 10mm bead in a tight zigzag pattern is recommended to reduce the risk of squeaking, assist with the fixing strength and to ensure boards remain tight on the batten across their full width.

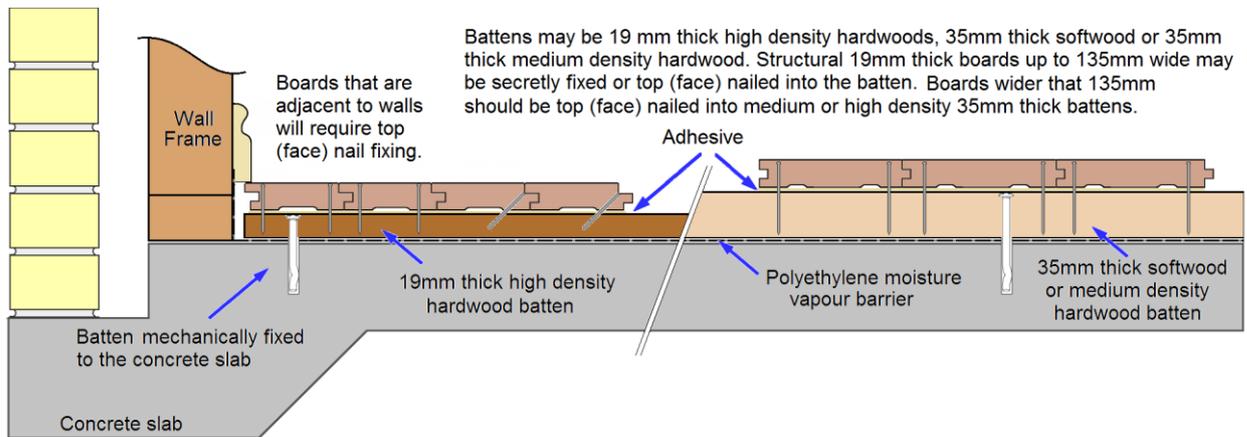
For secret fixing to battens, staples or cleats are used at each batten crossing. For top (face) nailing of boards to battens, at each batten crossing, one or two nails are required for boards up to 65mm wide, two nails per board are required for boards exceeding 65 mm in width up to 135mm and for boards wider than 135 mm fixed to battens, three nails are required. Top (face) nailing is to be undertaken uniformly with respect to edge distances and alignment across the floor.

When fixing into battens, the batten needs to be sufficiently thick. The properties of the batten material used and the board size will govern the size of batten used. If battens are of lower density including softwood, cypress and hardwoods less than 750 kg/m³ in density (e.g. Tasmanian Oak) then battens should be a minimum of 35 x 70 mm. Where high density hardwood battens are used, the minimum size is 19 x 60mm. Boards up to 135 mm wide may be secretly fixed or top (face nailed) into either the lower density 35mm thick batten or the higher density 19mm thick batten. Boards wider than 135mm should be top nailed into minimum 35 x 70 mm medium or high-density hardwood battens (such as Tasmanian Oak or Spotted Gum). Note that secret fixing of boards up to 135mm wide is permitted with battens over a slab but not when laid on joists. This is because the floor is not part of the building structure and conditions beneath the floor are more stable than a floor laid on joists that is open or has a closed-in subfloor space beneath.

In warmer humid or moist localities, additional care is required to cater for possible greater expansion. Therefore, particular consideration should be given to board moisture contents, providing for expansion, board size, the species used and the fixing method.

The recommended fixing of the flooring is provided in the diagrams below in conjunction with the fixing specifications.

Secret and top (Face) nail fixing structural 19mm thick flooring to battens over a concrete slab



Fixing specifications

For all installations in conjunction with mechanical fixing, apply 6 to 10mm beads of flooring adhesive to the battens in a tight zigzag pattern.

Secret fixing

- Board widths up to 85mm wide into 19 mm thick battens - 32x15 gauge staples or 38x16 gauge cleats.
For greater fixing strength (e.g. humid locations) or board widths up to 135mm wide - 38x15 gauge staples or 38x16 gauge cleats.
- Board widths up to 85mm wide into 35 mm thick battens - 45x15 gauge staples or 45x16 gauge cleats.
For greater fixing strength (e.g. humid locations) or board widths up to 135mm wide 50x15 gauge staples or 50x16 gauge cleats.

Top (face) fixing

- For board widths up to 135mm wide into 19 mm thick battens – Machine driven 32x2.2mm T-head nails.
- With 35 mm thick battens – Machine driven 45x2.2mm T-head or 45x2.5 hand driven bullet head nails.
For greater fixing strength (e.g. warmer humid locations). Machine driven 50x2.2mm T-head or 50x2.8 hand driven bullet head nails.