Bamboo Flooring
Industry Standards

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# Bamboo Flooring Industry Standards

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Introduction

Scope

This publication provides a reference guide for the installation of bamboo flooring laid as floating floors or by direct adhesive fix to structural subfloors. Generally floors of this type are of a laminated product made up from small pieces of bamboo bonded together or the strand woven product which is processed from longer strands of bamboo. The guidelines cover flooring that fits together with either a tongue and groove joint or a profiled locking system and products that are prefinished or site sanded and coated. When installing a bamboo floor many aspects must be considered and this includes assessing the house design, the environment in which the floor is to be laid and the desired appearance of the finished floor. These aspects are covered together with aspects relating to product selection, board widths and the finish system that has been applied.

The flooring process

Most bamboo flooring is manufactured in China from bamboo stems that are usually about 4 years old. After harvesting the stems are cut lengthwise into a number of pieces prior to further processing into laminated and strand woven flooring.

The manufacture of laminated bamboo flooring is quite different to strand woven bamboo flooring. Laminated product initially requires small sections about 30 mm wide to be machined in rectangular shapes (25 mm wide and 6 mm thick), treated against insect attack and then kiln dried prior to board fabrication. The dry rectangular pieces are then either glued horizontally or vertically to provide the desired style of product.

With strand woven flooring the bamboo pieces are cut into finer strands. These strands are then glued back together to form a sheet or beam from which raw boards are cut. Strand woven bamboo flooring is manufactured by two different processes known as the hot press and the cold press process. With the hot press process pressure and heat are applied to form sheets that are then cut into boards. From the cold press process, heat to cure the adhesive is applied after pressing the fibers into beams. The beams are then cut into boards.

For internal flooring each of these processes can provide quality product. Due to the pressing processes with strand woven products they are denser and harder than laminated flooring.

Bamboo flooring is available in natural tones or the feed material for each product type, prior to kiln drying, can be steam and heat treated to produce a darker tone. This differentiates the ‘straw’ and ‘coffee’ colours available.
Bamboo flooring is mostly supplied prefinished. The surface exposed to view in the floor is generally a UV cured coating system that may have additives to make the coating tougher.

Once board blanks are produced and the exposed face coated, they are machined to provide the tongue and groove or click together system to the edges and ends of the boards. Additional coating is then applied to the edges and underside of the boards, generally with polyurethane.

Various quality checks are applied throughout the process and the product is finally packed for shipment.

**The owner’s choice**

Aspects relating to what customers desire is of paramount importance and should not be taken lightly. They are relying not only on the expertise of those who have manufactured the product but also advice on the range of products available, differences between installation methods and ongoing maintenance. Each of these aspects can influence the owner’s satisfaction with their floor. Owners are much more aware and have much more access to information than ever before, however they are unlikely to have the same depth of knowledge as those dealing with bamboo flooring on a day to day basis. It is important to accommodate customer preferences, but this should not be to the detriment of the performance of the floor or its final appearance. Where customer preferences cannot be accommodated then this needs to be brought to their attention. Colour variation between showroom samples or production batches and the product provided and provision of expansion joints are two areas which affect appearance and may necessitate specific discussion with the owner.

**Environmental benefits**

Bamboo is a renewable resource that has been used as a construction material over the centuries. Bamboo differs from timber in that it is classified as a grass and as such it has the ability to grow to maturity in about 6 years. Due to this fast growth rate bamboo has a high yield for the land area planted. Fast growth results in a high release rate of oxygen back to the atmosphere and similarly carbon dioxide is absorbed from the atmosphere. The root system remains unharmed after harvesting and re-growth occurs rapidly. Forest management practices to international standards can also be met which promotes environmental sustainability and social responsibility.

Bamboo flooring is a manufactured product and uses adhesives in its manufacture similar to many timber based products. Due this there are requirements concerning formaldehyde emissions and in Europe it is necessary that bamboo flooring complies with emission class E1. Claims of compliance with this emission class are often evident on the packaging and literature relating to bamboo flooring entering Australia.

Bamboo is able to offer many environmental benefits but this still requires sound management practices regarding the land being used for production, in the harvesting and in the factories producing the flooring. From an environmental perspective embodied energy and transportation, as with most products from China, also forms part of the equation which can be a factor overlooked in its carbon footprint.
1.0 Product types & installation methods

1.1 Product types

Bamboo flooring is available in a variety of product types. The main types are horizontally laminated, vertically laminated and strand woven. There are, however, other product types on the market which include engineered constructions of strand woven bamboo. The properties of laminated and strand woven differ markedly. As indicated above, during the manufacturing process a darker toning can be added through a heat treatment process prior to board manufacture. Products are therefore available in the lighter natural colour, the darker ‘carbonized’ and in strand woven products both natural and carbonized can be mixed to provide boards with a contrasting appearance. Both product types are available as prefinished boards and some suppliers also provide uncoated boards for site sanding and finishing. In addition to the colour imparted through carbonization, tinted coatings from some suppliers can provide tones from very light to very dark.

The first of the three adjacent photos shows a natural colour horizontally laminated floor characterized by the whorls in the boards. In contrast to this the vertically laminated board in the second photo is characterized by a blend of deeper and lighter tones running down the length of the board. A more blended appearance is achieved with the strand woven product shown in the third photo.

1.2 Board sizes and micro-bevel

Board sizes will vary to some degree between manufacturers and production methods. As such there are no standardized board dimensions. Often board widths of about 90mm up to about 130mm to 150mm will be available. Board thickness is often 14mm or 15mm. The flooring is packed as a set length generally between 1.8m to 2.0m. Prefinished product is also manufactured with a micro-bevel. This is where the sharper edges of the board have been removed and it enables boards to fit together without noticeable lipping. It is therefore accepted that due to this the edges of the boards are defined in the floor once laid.

1.3 Floating and direct adhesive fix applications

Bamboo flooring can be either ‘floated’ or direct adhesive fixed over the subfloor. When we refer to ‘floating’ floors the boards are fixed to each other but they are not fixed to the subfloor. A foam underlay is used between the subfloor and bamboo flooring and many products also act as a moisture vapour retarder. With floating floors the flooring can be thought of as a continuous sheet and therefore provision must be made to allow this ‘sheet’ to expand and contract freely under changing environmental conditions. Direct adhesive fixed floorboards
are installed with a polyurethane flooring adhesive to the subfloor which, depending on the subfloor type, may have an applied moisture vapour retarder. Again expansion allowance is important and must be able to accommodate the cumulative effect of individual board movement. Both systems work well, but the feel and sound when walked on will differ between the two.

1.4 Profiles

The profile generally differs depending on whether the flooring is to be direct adhesive fixed to a slab or sheet subfloor such as particleboard and plywood, or ‘floated’ over a subfloor where the boards are fitted with a click together system to the edges and ends of the boards. The difference in these two systems is shown in the photos below with the T&G system on the left and the interlocking (glueless) system on the right.

1.5 Coating systems and gloss levels

From some suppliers product will be available unfinished so that it can be sanded and coated on site. With these floors and as shown in the photo the micro-bevel at board edges is no longer present and therefore board edges are less defined. Sanding and coating on site can be beneficial in permitting the final appearance to be achieved at the end of the project after other trades and it also provides for coating choice. However, although a high standard of finish is achievable, site sanded and finished floors generally contain some imperfections but where such imperfections have a limited effect on the appearance of the floor they are considered acceptable. In the inset some coat leveling aspects are visible in reflected light.

With most bamboo flooring prefinished in the factory, a very high standard of finish is achievable. With many products the coating to the exposed face consists of a multi layer system including fillers, sealers and final coats with additives such as aluminium oxide to provide a tough wear resistant surface. This is where coloured stains may be used in the coating system to add different colours or tones to the boards. The coating is done in a controlled environment with UV curing that provides a fully cured board at the end of the process.

Products are available in different gloss levels from a satin or low sheen finish to a full gloss level. It should however be noted that not all suppliers may provide both in the range of products they sell. Many of the coating systems used are water based.
2.0 General properties

2.1 Colour variation

Bamboo flooring is subject to some natural colour variations within the species and when tinted, product is manufactured there can have small differences in the toning, to some degree between boards and between different production runs. Purchasers need to be fully aware that natural colour variations and those resulting from tinted coatings will occur and that there may be small differences in the packs supplied, particularly so if not manufactured at the same time. For this reason some suppliers suggest that boards from different packs need to be blended into the floor during installation.

The customer needs to be fully aware and accepting that colour variation occurs. If there are significant concerns regarding the supply of the flooring it must be raised with the supplier prior to laying. Normal colourations between boards do not provide grounds for replacement and any concerns need to be raised before work commences.

2.2 Hardness

Hardness of flooring in Australia is measured using the Janka test. This is not directly related to how hard or easy the bamboo is to work on with various tools, but is a measure of the resistance of the product to indentation. The Janka hardness of laminated product (vertical and horizontal) averages about 7 and for strand woven it is about 14.5. As such the strand woven product is much harder. In terms of the general categories used with timber flooring, laminated bamboo products would be regarded as hard and the strand woven product as very hard. It should be noted that even ‘hard’ bamboo and timber flooring products will indent with ‘stiletto heel’ type loading as shown in the photo. As such some care with footwear is still required.

2.3 Wear

Like all floor coverings, factory coated bamboo floors will show signs of wear over time depending on the amount of use the floor receives. Some coating systems with additives such as aluminium oxide provide a very tough coating system which can be expected to take longer to show signs of wear. If floors are site sanded and coated then wear relates to the products used to coat the floor. Implementing a regular cleaning and maintenance program will ensure the floor remains in the best condition possible. Note that coating and surface finish warranties can be quite specific in what they cover and can exclude high wear areas. The warranty is more to cover a problem with the manufacture or initial application of the factory coating rather than aspects relating to normal wear in the floor.

2.4 Product moisture content and the effect of humidity

When considering the moisture content and movement characteristics of the products it is necessary to understand that the laminated product is quite different to the strand woven product, in a similar way that softwood timbers differ to hardwood timbers. Like timber, bamboo is hygroscopic. This means that bamboo flooring will absorb moisture from the air under high humidity conditions and under low humidity conditions it will release moisture back into the air. When this occurs in natural products such as bamboo and timber there is an increase in board width with moisture uptake and a decrease with moisture loss. This highlights the need to accommodate this movement with expansion allowance at installation.
The coatings used in prefinished bamboo flooring will also influence and slow, to varying degrees depending on the coating system, moisture movement in and out of the product.

It is considered that the laminated product, vertical or horizontal, acts in a more similar way to solid timber than does the strand woven product. This is because the laminated product is less modified during the manufacturing process. The manufactured moisture content of laminated bamboo is therefore more in line with timber at 9% to 11% moisture when manufactured and installed.

In contrast to this the strand woven product is manufactured under high pressure and temperature and, with greater use of adhesives, is of much higher density. Therefore its characteristics of moisture uptake and loss differ to laminated bamboo products. It has been found that with strand woven bamboo there is a wider range of manufacturing moisture content with some flooring manufactured at lower levels of 6% to 8% moisture content, while other flooring may be manufactured at about 9% to 11%. Both these ranges fall within the Chinese quality standard for the manufacture of bamboo flooring (GB/T 20240-2006) which indicates a range from 6% to 14%. However, it is important to note that strand woven bamboo is NOT timber and therefore direct comparison of suitable moisture contents should not be made.

### 2.5 Equilibrium moisture content

The equilibrium moisture content (EMC) is the moisture content that hygroscopic products such as bamboo, solid timber and even concrete attain under specific conditions of relative humidity (RH) and temperature. Solid timber flooring in conditions of 20°C and 60% RH will attain a moisture content of about 11% whereas under these same conditions concrete will attain a moisture content of about 1.8%. Bamboo, and particularly strand woven bamboo, is different from either solid timber or concrete. It is considered that the EMC of laminated bamboo will be more similar to solid timber and that with strand woven bamboo its moisture content sits about 2% to 3% below that of solid timber. Hence with strand woven bamboo, where conditions inside a dwelling may average about 20°C and 60% relative humidity (RH) strand woven bamboo is 8% to 9% moisture content. In effect this means that if strand woven bamboo is 8% to 9% moisture content in these conditions then its moisture content will not change if the temperature remains at 20°C and relative humidity at 60%. As such if there is no moisture content change then there is no expansion or shrinkage movement of the boards.

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<td>Relative humidity 60%</td>
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<td>Solid timber</td>
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<td>10% to 12%</td>
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### 2.6 Board expansion with moisture content change

There are three aspects that need to be considered here. Firstly, the rate at which bamboo products absorb moisture, secondly the actual expansion relating to the increase in moisture content and thirdly the extra restraint provided by adhesive fixing compared to floated installations.

Although formal research has not been undertaken to date, observations and industry testing indicate that the rate of moisture uptake differs between vertically laminated, horizontally laminated and strand woven products: the rate of moisture uptake and associated expansion in prefinished vertically laminated being greater than horizontally laminated or strand woven. With the horizontally laminated and strand woven products the width movement is also generally less than that of high or medium density hardwood timbers.

When floors are floated movement through board expansion is greater than with direct adhesive fixed floors. For this reason greater allowance to accommodate this movement through intermediate expansion allowance, expansion joints across doorways, as well as expansion beneath skirtings is required for floating installations.
2.7 Moisture transfer through strand woven bamboo flooring

The transfer of moisture into and through strand woven bamboo flooring is governed by three factors: the initial moisture content of the product, differences in the upper and lower surface coatings and the moisture that is available to be absorbed.

The hygroscopic nature of the product has been outlined in section 2.4 indicating that when the bamboo flooring has been appropriately dried and accustomed to the conditions within a dwelling it will still absorb moisture from the air during times of high humidity and during times of low humidity it will lose moisture to the air. As such with these changes in moisture content the bamboo flooring will swell, mainly in board width, with increased humidity and shrink with reduced humidity. Similarly if bamboo flooring is in contact with a surface that is damper than the bamboo it will also absorb moisture from that surface. It is therefore not only the moisture content of the product in relation to air humidity that can cause a change in moisture content but also that the product can absorb moisture (or release it), depending on the relative dampness of the two surfaces. These concepts are shown in the diagram below.

It is also clear that the initial moisture content of the product will influence whether the flooring is prone to taking up moisture after installation. As indicated some bamboo flooring is manufactured and laid at moisture contents between 6% and 8% where its in-service or EMC moisture content is likely to be between 8% and 10%, depending on the humidity in the locality and noting that it could also be a few percent higher in the tropics and other more humid locations. Therefore this lower moisture content flooring will be more prone to moisture uptake and expansion after installation than flooring that is manufactured and installed at 9% to 11%.

Low moisture content flooring will also be more prone to absorbing moisture from moister surfaces over which it may be laid. Note that with reference to section 2.5 a concrete slab at, for example, 3.5% moisture content is more moist than bamboo flooring at 7% moisture content and the slab can be expected to transfer moisture to the bamboo flooring, unless a suitable moisture vapour retarding barrier is used. However, if the bamboo was higher in moisture content at say 10% when manufactured and installed, then transfer from the slab would not be significant. Therefore when we are considering the transfer of moisture between different products or with the air, moisture content figures between products are not directly comparable and it must be taken into account which is actually drier. The EMCs associated with the different products needs to be taken into consideration.

If we now consider the coated surfaces of the bamboo it is evident that many of the products come prefinished with a multi-coat UV cured system on the exposed face of the board whereas on the edges and underside of the boards there is often only a single coat of polyurethane. Industry studies have indicated that the moisture transfer rates through upper and lower board surfaces can differ, in that the surface coating to the upper exposed face of the board is often much less moisture permeable than the coating on the lower surface of the board. As shown in the photos below significantly less cupping occurred with the upper board face on the damp cloth when compared to the lower face on the damp cloth. This does however vary between products as individual coating types will differ. In some products the effects from this test are more even.
Consequently, with strand woven bamboo flooring, the control of moisture movement into the product needs careful consideration. This is particularly so in more humid environments and where conditions beneath the floor can allow moisture from a moister subfloor to transfer into the drier bamboo floor above. As a result of this and likely pressure effects in floors, a cupped appearance can result. Slabs and subfloors may be considered ‘dry’ and suitably dry for other flooring products however if moister than the bamboo flooring above, the floor’s appearance and at times performance can be affected. It should be noted that when a bamboo floor is laid with moist conditions beneath, then conditions can over time become more severe due to the very low permeability of the product. As such there can be a buildup of moisture beneath and in the lower section of the product over time. The first photo below shows a highly cupped strand woven bamboo floor laid on particleboard over a damp subfloor space that was subject to water ingress as shown in the inset. The second photo shows a cupped and peaked floor resulting from humid conditions and slab moisture.

In addition it should be noted that a cupped appearance is not always associated with high moisture meter readings in the floor and in such instances it must be considered that pressure effects can also show as a cupped appearance known as peaking, generally with flooring of lower moisture content rising in moisture content to reach the EMC of the installation environment. In other instances there is also likely to be a combination of these two effects. Peaking is the result of expansion pressure being resisted by only the upper shoulders of the board and can be more pronounced when the undercut is greater, as shown in the photo below.

2.8 Installation methods and performance of bamboo floors over different subfloors

Much of the flooring, laminated or strand woven is laid as a floating floor and, provided the installation includes an appropriate moisture vapour retarder either separate to or included as part of the underlay and that recognised installation practices are used, then there have been few marketplace concerns. Some care is required in more humid localities as floorboard expansion can be greater than anticipated. With the likes of hallways at right angles to each other, the floor can be skewed and cause boards to move from beneath skirting giving the appearance of shrinkage in length as shown in the photo. Similarly, if sufficient expansion allowance is not provided the floor may buckle. Therefore, due allowance for expansion and separating sections of the floor, as outlined in later sections, requires consideration in such environments.
With floors that are direct adhesive fixed to particleboard or plywood and it is known that subfloor conditions are dry, such as an upstairs particleboard subfloor, then similarly floors are performing well. Additional care is necessary when the bamboo flooring, laminated or strand woven is adhesive fixed to a particleboard or plywood sheet subfloor where there is soil beneath and in particular if the subfloor space is enclosed.

When laying floors by direct adhesive fix to a concrete slab, and particularly with strand woven bamboo, then the aspects as outlined in section 2.7 require the necessary consideration. No two dwelling environments are the same, no two concrete slabs are the same and it is also not always possible to know the exact properties of the bamboo product being laid. For these reasons additional care is necessary. Added precautions, due to the low permeability of strand woven bamboo, that are at times being taken include doubling up on the moisture vapour retarder. With a number of the applied moisture retarders it is known that a double application is significantly more effective than a single application. It is important to also ensure that the products are applied at the correct application rate as this determines the thickness and effectiveness of the vapour retarder. Bamboo manufacturer installation instructions need to be adhered to with regard the moisture retarder and adhesive products that are to be used. Care is also needed with construction joints in slabs that they are sealed against moisture vapour. In locations that are more extreme in terms of climate variability some manufacturers have developed an engineered strand woven product which is noted for increased stability, as shown in the photo.

2.9 Measuring the moisture content in bamboo products

Moisture meters do not directly measure moisture in a product; they measure an electrical property that is influenced by moisture. However, there are other aspects of some products that also have an influence on meter readings including adhesives and density variations. For these reasons moisture meters do not generally provide good guidance as to the actual moisture content and the only way to obtain a reliable estimate of the actual moisture content is to undertake an oven dry test. As no Australian standards are written covering the moisture content testing of bamboo by this method, testing is often undertaken in accordance with the provisions of AS 1080.1 Timber – Methods of Test – Moisture content. The equipment used for oven dry moisture content testing is shown in the photo.

With regard to moisture content testing in strand woven bamboo, oven dry moisture contents of 6% to 9% have been associated with resistance moisture meter readings of about 12% to 17% and capacitance moisture meter readings of about 10% to 15%. Board moisture contents by the oven dry test in strand woven bamboo are generally below that of meters but the degree to which they are below varies and is also greater with moisture affected flooring. Therefore if moisture meters are used with strand woven bamboo then great care is required in interpreting the results and being aware of the limitations. Capacitance moisture meters can be effective in providing a guide as to moisture content differences that may be occurring between one area of a floor and another. When capacitance moisture meters are used with strand woven bamboo, it is usual to set the specific gravity setting on the meter to 1.0 (equivalent to a density of 1000kg/m³). Meters of this type differ in their properties (e.g. depth of reading, internal electronics) and therefore it is necessary to be accustomed with the properties of the meter being used to avoid incorrect interpretation of results. Use of a capacitance meter is shown in the adjacent photo where the very high reading is indicative of moisture beneath and consistent with dark discolouration and movement that was occurring in the boards.
3.0 Pre-installation

3.1 Locality and dwelling environment

Provided flooring is protected from subfloor moisture it is mainly the relative humidity in the air that influences the moisture content of bamboo flooring. The initial moisture content of the product will also play a part and in more humid localities a higher moisture content product (8% to 10%) is going to be more suitable.

Within a dwelling there are many things that influence the relative humidity and a comfortable living environment is not as extreme as the conditions outside the dwelling. In cold climates the internal environment is moderated by heating when cold wet conditions cause high humidity outside and in summer months when conditions can be hot and humid refrigerative air-conditioning is often used, which moderates the high external humidity. In places experiencing hot dry summers evaporative coolers add moisture to the air, thereby also moderating the conditions. Furnishings such as curtains and rugs also tend to moderate the internal environment not only reducing heat gain in the floor but also absorbing and emitting moisture depending on the humidity, similar to the floor. Generally the conditions that we feel most comfortable in, the bamboo floor will also perform the best.

Care is necessary not to create conditions within the dwelling that we would feel particularly uncomfortable in. More extreme use of heating and cooling systems, unfurnished dwellings and permitting hot humid conditions for extended periods inside the dwelling can all have a detrimental effect on bamboo floors. Bamboo flooring products are well suited to dry-to-moderate conditions including the main populated coastal cities.

However with higher humidity conditions greater care is necessary. Often during the building phase when the dwelling is not being lived in, internal conditions tend to more closely reflect external conditions. Floor installation at the end of the building process, particularly if the building is during a humid time of the year, is therefore necessary. Other humid localities include the tropics, buildings within a few hundred meters of the coast, areas with large expanses of grass around them such as farmland, gullies with tall surrounding trees and where the dwelling is often shaded and often near a watercourse. It is important to check both the manufacturer’s installation recommendations and warranty conditions that the product being considered is designed for the dwelling environment.

3.2 Building site conditions

With regard to the exterior of the building or dwelling all gutters, downpipes and drainage systems need to be in place and operational prior to laying the floor. Similarly, ground work needs to be sufficiently completed to ensure water drains away from the building and that no ponding of water occurs either adjacent to slabs and footings or beneath the building.

Prior to product being delivered to site the building needs to be weather tight with all windows and doors in place. Wet trades including plastering, tiling, painting and plumbing should be complete and the building then given time to dry out from higher levels of moisture released from these trades.

3.3 Storage and handling

All products should be handled with care and unopened cartons should be stored in dry conditions and elevated at least 100 mm off ground floor slabs. Conditions within the dwelling should resemble as closely as possible the in-service conditions of the completed building or dwelling. If the normal in-service conditions of a building are that they are air-conditioned or heated at the time of the year when the floor is being installed then if possible these conditions should be replicated prior to floor installation and then maintained. Temperatures in the 20s and relative humidity of between 40% to 60% are indicative of the dry to moderate conditions that are best suited to floor installation with many of products available. The focus should be on comfortable living conditions.

3.4 Acclimatisation

Prior to laying the floor some consideration needs to be given to acclimatising the product. Although the word ‘acclimatise’ is used it often has a different meaning to that used with solid timber flooring and therefore individual manufacturer details need to be considered. In some instances manufacturer recommendations state that no acclimatisation is necessary, others indicate that acclimatisation by the processes used with solid timber flooring should be undertaken while others state that storage for a number of days in the installation environment is all that is necessary to acclimatised or accustom the product to the installation environment.
4.0 Subfloors

4.1 Appropriate subfloors

For both floating and direct adhesive fix applications a wide range of subfloors can be laid over provided the subfloor is in a suitable condition to accept the flooring as outlined below. In the case of direct adhesive fix applications the structural integrity of the subfloor must be adequate to withstand forces associated with board expansion.

Suitable subfloors may include concrete, particleboard, plywood, resilient flooring and ceramic tiles. For the specifics relating to the preferred installation method, the product suppliers’ installation recommendations need to be adhered to.

In accordance with the Building Code of Australia bamboo flooring is not to be installed in wet areas such as the bathroom, toilet and laundry. Kitchen and food preparation areas are not deemed to be wet areas.

4.2 Subfloor construction, flatness and cleanliness

All subfloors need to be sound and structurally complying with relevant Australian construction standards (i.e. the supporting timber or concrete if overlaid with tiles or resilient flooring etc.).

All subfloors need to be sufficiently flat to accept the flooring system (floated or direct adhesive fix). For floating floors this generally does not exceed 3mm beneath a 1m long straight edge. For direct adhesive fix applications 3mm beneath a 3m long straight edge applies. Specific recommendations for individual flooring products or as recommended by adhesive manufacturers may be tighter than this and in such cases would apply. Where floors are not sufficiently level, leveling compounds, grinding or other means to level the subfloor need to be undertaken.

For floors direct adhesive fixed to concrete subfloors, additional provisions apply.

Any intermediate layer between the flooring and the subfloor (e.g. ceramic tiles over a slab) needs to removed or tested to ensure adequate adhesion of the tile to the subfloor. If adhesive fixing to tiles, the flatness provisions outlined above apply. The photo shows poor adhesion due to inadequate preparation of the tiles.

The surface on which the flooring is to be adhesive fixed must be free from all contaminants that could prevent or reduce the effectiveness of the adhesive. In particular the surface needs to free from any waxes, grease, paint, sealers and other similar substances. Sanding or grinding may be required to provide a suitable surface.

When leveling compounds are used they are to be applied according to manufacturer recommendations and care is needed to ensure sealers used in conjunction with the product are covered. Sealers can prevent adhesion of adhesives. The leveling compound also requires sufficient tensile strength to accommodate the expansion forces from the adhered flooring. Leveling compounds with low tensile strength are to be avoided.
4.3 Concrete slab subfloors – Protection from moisture

Irrespective of whether the floor is floated or direct adhesive fixed, steps need to be taken to prevent possible moisture uptake into the flooring from the subfloor. Moisture absorption from beneath the floor can result in greater levels of expansion resulting in the likes of cupping, buckling and delamination of adhesive fixed floors.

Concrete slab subfloors

With regard to concrete slabs aspects relating to the water cement ratio and placement of the concrete have a direct bearing on the permeability of the slab. Hence a slab that is many years old is not necessarily a dry slab. Slab moisture can also change seasonally with changes to the water table level. Higher strength concrete often used in high rise development is less permeable and presents less risk. Slabs that are elevated also present less risk than slabs that are on the ground. A slab that is below grade, cut into an embankment or where the slab is near the same level as patios or the ground level outside present the greatest risk. With additions to houses the joint between new and old slabs also presents a high risk and needs to be attended to in order that moisture and moisture vapour do not affect the floor.

Concerning slab moisture assessment, concrete moisture meters may be used as well as in-slab relative humidity tests. Such measures along with assessments of the risks outlined above are necessary for all slabs. New slabs may give readings with a concrete capacitance moisture meter of about 6% a few days after placement. Within 3 months the readings may be down to about 4% and after two years readings may settle to about 2%. Once a slab is known to be reducing in moisture content like this other means of protecting against possible slab moisture can be employed. Note that a slab that is for example 6 years old and giving readings of perhaps 4% is a high risk slab because after this period of time moisture meter readings should have been lower. Note also the limitations of concrete moisture meters. They measure moisture near the top of the slab and once a floor is laid moisture levels generally increase toward the top of the slab.

In-slab relative humidity measurement is a method of slab moisture assessment that is increasing in popularity throughout the world and is considered to provide a more accurate assessment of the potential for slab moisture to affect a floor. That is the test takes into account that moisture in a slab increases toward the top surface of the slab once a floor is laid. In-slab relative humidity remains relatively high in all slabs and information from overseas suggests that in-slab relatively humidities of 80% to 85% are at a level where flooring products can be considered and with bamboo flooring other means of protecting against possible slab moisture can be employed. In-slab relative humidity requires holes to be drilled in the slab, the hole plugged and readings with a hygrometer taken some time later.

Therefore prior to laying a direct adhesive fix floor the level of moisture in a slab needs to be assessed and when down to suitable levels an applied moisture vapour barrier, if directed by the flooring product manufacturer, is to be used. Often this moisture vapour barrier is specified to provide compatibility with the recommended adhesive.

With floating floors an underlay and moisture retarding layer is a standard recommendation of bamboo flooring manufacturers. Many bamboo flooring products have specific underlays that are to be used and contain an integral moisture retarding layer.

Bamboo flooring product supplier recommendations concerning the desired system are to be followed and underlay or applied moisture vapour retarding products are to be applied in accordance with manufacturer recommendations.
4.4 Timber and sheet subfloors – Protection from moisture

Bamboo flooring can be laid over particleboard or plywood subfloors on joists and often on solid timber flooring on joists as either a floating floor or an adhesive fixed floor. It is essential to ensure possible moisture, in either the sheet or timber subfloor and the subfloor space beneath, does not affect the flooring being laid. Note that strand woven bamboo can be more sensitive to subfloor conditions than solid timber flooring due to its low permeability.

Subfloor Spaces and Surrounds

The drainage system provided to the dwelling site needs to ensure that run-off water will drain away from the building perimeter (not towards it) and that run-off water is prevented from entering the subfloor space. The ground beneath a suspended floor should also be graded and closed drainage systems used if necessary so that no ponding is possible. The subfloor space must be free from all building debris and vegetation. Landscaping, patios and the like should not limit air-flow around the external perimeter of the subfloor space, and structural elements should also not limit air-flow.

Where the subfloor space is enclosed the provisions as for solid timber flooring also apply. Ventilation to the subfloor space is a requirement of the Building Code of Australia (BCA). If the recommended natural ventilation cannot be provided to subfloor spaces (e.g. due to adjoining decks or where foundations are cut in), a mechanical ventilation system should be installed which replaces all of the air in this space on a regular basis and prevents the formation of ‘dead-air’ pockets. Where ventilation is compromised (e.g. subfloor obstructions, fences and adjoining structures) consideration should be given to the use of more than the minimum number of vents, ensuring that cross flow is achieved.

If there are doubts over the subfloor humidity and maintaining dry conditions at all time beneath the floor (areas of high water table or reduced air flow etc.), a polyethylene membrane laid over the soil should also be considered (taped at joints and fixed to stumps and walls), in addition to increased ventilation. With dwellings on sloping blocks, the possibility of seepage should be taken into account and appropriate control measures taken prior to the installation of the floor.

Subfloor ventilation through permanent vents that exceeds minimum Building Code of Australia (BCA) requirements is recommended where any timber floor is installed. The levels outlined in the BCA (6000 mm² per meter length of wall in moderate to higher humidity areas) are primarily to limit the moisture content of subfloor framing timbers, which can generally tolerate greater fluctuations in moisture content. The recommended minimum ventilation is 7500 mm² per meter length of wall, with vents evenly spaced to ensure that cross ventilation is provided to all subfloor areas (refer to the figure below).

BCA relative humidity zones and associated BCA ventilation requirements are also provided below.

<table>
<thead>
<tr>
<th>BCA Sub-floor Ventilation Requirements</th>
<th>Min. Sub-Floor Ventilation mm²/m of wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLIMATE ZONE, CONDITIONS &amp; SELECTED LOCATIONS</td>
<td>No membrane</td>
</tr>
<tr>
<td>1 Average Prec RH &lt; 60%</td>
<td>2000</td>
</tr>
<tr>
<td>2 Average Prec RH &gt; 60% and 3pm RH &lt; 40%</td>
<td>4000</td>
</tr>
<tr>
<td>3 Average Prec RH &gt; 70% and 3pm RH &lt; 40%</td>
<td>6000</td>
</tr>
</tbody>
</table>

Source: BCA 2005 Vol 2
In some localities, to meet constraints associated with energy efficiency, it may be decided to reduce ventilation levels to the values provided in the BCA. The BCA also outlines that a moisture barrier over the soil beneath the building reduces ventilation requirements and this approach is equally applicable to timber floors (refer to the table above). If ventilation below the recommended level is used, due consideration should be given to alternative measures as outlined above and particular attention should be paid to ensuring that the subfloor space remains dry throughout all seasons. The type of vent may also need to be considered with buildings in bushfire areas which limits the mesh size used in vents. It should be noted that the maximum vent spacing irrespective of net ventilation area is 2 m and that any screens that may be necessary in bushfire areas or for vermin proofing may restrict airflow and this may need to be compensated for.

**Moisture Content of the Subfloor**

It is necessary to check that the existing timber or sheet floor moisture content is appropriate to accept the new floor. The cause of any excess moisture (wetting during construction, leaks, inadequate subfloor 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 testing. Due to the adhesives in sheet products resistance moisture meter readings in these products as a subfloor, sometime after installation, are generally higher than oven dry moisture contents. Resistance moisture meter testing of subfloor joists can also provide an indication of general sheet subfloor moisture contents. Sheet subfloors should not be more than a few percent higher than the expected average in-service moisture content. For example in main coastal major cities the average in-service moisture content is about 11% and therefore the subfloor should be no more than 13%. In tropical locations timber may average 14% and therefore 16% in the subfloor could be expected.

**4.5 Other subfloors and those requiring acoustic rating**

Bamboo flooring may also be installed over subfloors not specifically outlined above; however as these are less common the flooring product manufacturer should be consulted on advice regarding the product and installation system to be used.

A degree of acoustic isolation is achieved with either floating installation on underlay or with some adhesive fixed systems. However, in apartment developments there is a requirement to meet not only BCA requirements of an $L_{nTw}$ (plus a modification factor C1) to be not more than 62dB for floors separating dwellings but also the provisions under the Strata Schemes Management Act where the Body Corporate can set its own requirements.

For comparative purposes it should be noted that carpet will generally achieve an $L_{nTw}$ of about 40dB and for bare concrete with a 175 mm slab an $L_{nTw}$ may be about 70dB. Note that sound pressure is measured in decibels (dB) and an increase or decrease is perceived by us as a change in loudness. Most of us would notice a change of 3dB and a reduction of 10dB would sound about half as loud.

Due to these requirements specific underlays and installation practices need to be employed to achieve the required sound isolation. Aspects relating to the thickness of concrete subfloors play a significant roll and thinner timber floors generally result in less sound transmission than thicker flooring. Underlay performance relates more to the design of the underlay rather than the thickness. Timber flooring systems including acoustic underlays often provide about 10 to 20 dB attenuation (reduction in noise).

Hence with such applications advice from the flooring product manufacturer and others will likely be necessary.

**4.6 Heated slabs**

As bamboo flooring differs in type and properties between manufacturers not all products may be suitable for installing over heated subfloors. Therefore if installing a floor over a heated subfloor it is necessary not only to choose the correct product but also to follow the specific manufacturer installation instructions.

Products are available that can be both floated and glued down over heated concrete slab subfloors. Provided below is an outline of principles that need to be considered, although installation practice must follow manufacturer guidelines.

The slab must first be assessed that it is suitable for floor installation in terms of slab integrity, flatness and initially at a moisture level suited to floor installation over unheated slabs (refer to sections 4.2 & 4.3). Following this further drying is necessary. If this is not done heating of the slab will drive remaining moisture out after the flooring is installed affecting its performance. Hence the heating system must be operational prior to floor installation and further drying of the slab is achieved by applying heat for about 72 hours and then letting it rest for 24 hours. At this time a moisture vapour barrier may be considered for added protection.
Bamboo flooring can then be laid as either a floating or adhesive fixed installation in line with standard practices for the product being installed including recommended expansion allowance in both floor width and length. Forty eight hours after installation the heating system needs to be operated and temperature increased equally over a five day period up to a maximum temperature of 27°C and then maintained at this temperature for at least a further two weeks.

If the flooring is not prefinished and is to be sanded and coated then the floor needs to be cooled for about 3 days after installation and following the heat stabilization process, standard sanding and coating practices can be used. Note however that care should be exercised in the choice of coating that it is not prone to edge bonding and tram lining.

The system may then be used but be aware that timber floors should not be subjected to sudden changes and therefore temperatures should be either increased or decreased over a period of days to reach desired operating temperature with a maximum of 27°C. Some seasonal movement in the floor is to be expected and it should also be taken into account that the floor is now accustomed to dry conditions which should be maintained when external humidity is high. Ideally an internal humidity between 35% and 55% will generally provide conditions for best performance.
5.0 Underlays

With floating floors the underlay provides a cushioning effect between the bamboo floor and the subfloor over which it is laid. As such it also allows the floor to also accommodate the minor acceptable tolerances in the flatness of the subfloor. Many underlays also provide the role of a moisture vapour retarder and have this built into them with a plastic layer to prevent moisture vapour from affecting the flooring. However, this is not provided with all underlays and therefore moisture vapour transmission may need to be considered separately, such as by placing a 0.2 mm polyethylene plastic sheet over the subfloor first. In such instances the plastic sheeting is usually overlapped by about 200mm and the joints taped.

The underlay can also influence both the noise transmission through a floor (refer to section 4.5) and the noise emitted from the floor when walked on. Consequently, underlays come in a variety of materials depending on the properties that the manufacturer desires to achieve. Underlay products include expanded foams, polyesters, cork and rubber. In commercial applications where heavier loading may occur, a more dense product may be used.
6.0 Installation

The subfloors over which the product can be laid and the environmental conditions most suited to the individual products will differ. It is therefore essential that it be determined that the chosen product is suitable for a specific locality and micro climate (e.g. coastal or bushy gully), that the subfloor is suited to the specific product and that the installation method is suited to both the product and installation environment. The installation must therefore be undertaken to the product manufacturer’s recommendations.

Provided below is a general overview of the installation of floating floors and adhesive fixed floors. It is a description of the general process only, noting that it is the individual manufacturer recommendations that are to be followed with the actual floor installation.

6.1 Equipment required to lay the floor

The equipment necessary to lay the floor will differ a little depending on whether the flooring is to be floated or direct adhesive fixed and with floating floors whether it is T&G profile or an interlocking (glueless) joint system. However boards need to be cut and drop saws, circular saws and jigsaw are often used. General carpentry tools including tape measure, pencil, string line, hammer and a carpenter’s square are required. Specific to floor installation are tapping blocks, pull bars and means to assess subfloor moisture. Adhesives of various types may be necessary, with T&G floating floors generally using a cross linked PVA and direct adhesive fixed floors generally using a polyurethane flooring adhesive. Similarly, cleaning cloths and products for dealing with excess adhesive are also necessary. With direct adhesive fix applications subfloor leveling equipment, applied moisture retarders and sanding and grinding equipment or leveling compounds may also be required. Correct glue trowels are also needed and are specific to the adhesive manufacturer. Systems which include a moisture vapour retarder and adhesive generally need to be from the same manufacturer to maintain warranty of these products.

6.2 Safety

Safety is a priority and therefore correct use of power tools and use of products associated with the floor installation need to be in accordance with the manufacturer’s guidelines, safety instructions and application instructions as applicable for the equipment and products used. The work area also needs to be kept clean. Note also that wood and wood dust can be an irritant and that wood dust has been classified as a nasal carcinogen in humans by the International Agency for Research on Cancer (IARC).

6.3 For all installations

The flooring, irrespective of whether it is pre-finished or to be site sanded and finished, is to be checked at the time of laying for manufacturing imperfections that could become a concern in the finished floor. This includes aspects of grade, imperfections in board shape or damage to boards as well as coating imperfections. Manufacturers and suppliers expect to be notified of any such defect imperfection at this time in order that any concerns can be addressed promptly and not necessitating remedial work to a completed floor. Affected boards should be set aside and not laid.

Some suppliers indicate that the flooring should be laid from several different packs (at least 3) at the one time and if applicable, to mix together different production batches, to ensure a good mix of floor colour and tones.

The installer is responsible for the placement of the boards in the floor in terms of colour and length distribution. Some boards may blend better to existing moldings and placement of boards that create sharp contrasts that do not blend should be avoided. Ends joints need to be spaced and a minimum of 100mm is recommended by some manufacturers while others may recommend 300mm to 500mm, as shown in the photo. Some flooring with set length boards is laid to a pattern with a set stagger while in other case manufacturers recommend cutting starting boards to varying lengths.

All floors require expansion allowance at skirting and around fixed objects. Intermediate expansion allowance can be required in both the length and width of floors. The length and width at which intermediate expansion allowance is needed will depend on the individual product. With longer floors expansion joints are required at doorways due to the differential movement of different sized floors in different rooms.
A neater job is provided when door casings and jambs are cut for the floor to pass beneath and negates the need for more difficult scribe cutting. Similarly, any other moulds etc should be removed and replaced after floor installation.

In preparation for the installation, the direction that the floor will be run needs to be considered. Often for the preferred visual effect and for expansion reasons the floor is run parallel to the longer walls and down the length of longer hallways. If however there is strong incoming light on the floor this may affect the choice of direction with consideration being given to installing in the direction of incoming light. Light at oblique angles across the board widths can highlight minor variations in the board surface and between boards.

6.4 Floating floor installation

It should be noted that two products types may be floated over an underlay: the T&G profile and the interlocking (glueless) joint system (refer to section 1.4).

Aspects relating to the product chosen, on-site storage and acclimatisation, the in-service environment, subfloor condition, underlay to be used, safety aspects and equipment needed to complete the installation should all have been considered and be in accordance with the manufacturer recommendations, prior to the point of floor installation. Similarly the points outlined in section 7.1 should also have been considered.

Some general points with floating floor installation are as follows:

- All floors are laid on underlay which generally has a pre-attached moisture barrier and manufacturers generally require the inclusion of a moisture retarding barrier
- Floating floors are not to be fixed to the subfloor at any point. It needs to be ensured that the floor is free to move in all directions. That is, the floor is not to abut any vertical surfaces which include doorways, other adjoining floor surfaces, pipe work, benches or staircases. Similarly the likes of kitchen benches are not to be placed on the floor, but the floor is to be cut around them
- Manufacturer recommended expansion allowance to all vertical surfaces is to be provided noting that in more humid environments greater expansion can be expected and therefore expansion allowance toward the upper end of the manufacturer range is prudent. Similarly wider or longer floors should be provided with more than the minimum
- It is to be ensured that intermediate expansion joints are provided where recommended and that appropriate expansion joints at doorways are also provided. Subfloor expansion and construction joints running parallel to the direction of laying need to be mimicked in the bamboo floor above. Construction joints in slabs need to be sealed from vapour transmission.

The installation process differs a little between manufacturers but is generally as follows:

- The underlay is rolled out onto the subfloor with integral moisture barrier facing the subfloor as applicable. Joints in the underlay are butted together and taped to provide a continuous layer
- The first row of boards is laid with the groove side facing the starting wall and ensuring the recommended expansion allowance has been provided. Blocks or wedges can be used in the expansion gap to maintain the correct allowance. If the wall undulates then this row of boards will need to be scribed and cut so that the expansion allowance is even down the length of the wall. Also, consideration may need to be given that on the opposite wall the floor will not finish with a very narrow board. This can be another reason for cutting back the first row of boards.

T&G profile installation

- Where the flooring has a T&G profile some manufacturers indicate that the first few rows should be initially ‘dry fitted’ (without adhesive), so that it is then possible to check that floor is straight, that the required expansion allowance has been achieved to the starting wall and side walls and that end joints are appropriately spaced (a minimum of 100mm and preferably 300mm to 500mm apart). It can also assist in providing a straight floor to have the first board in the first row shorter than the adjacent first board in the second row
- Once this is done the rows are disassembled and then the boards glued together from the initial starting position with boards consecutively glued together in a staggered pattern. An unbroken bead of adhesive is placed in all T&G joints to the product manufacturer’s directions. This is necessary to provide the required bond strength and a degree of moisture resistance. The location of the bead or beads is important, can differ between manufacturers and may differ over the first few rows of boards to the main body of the floor.
- During the time when the adhesive is drying, often about an hour, the floor should not be walked on before proceeding with the installation of the remainder of the floor.
Throughout the installation both a tapping block, with groove fitting over the board tongue, and pull bar are used to gently tighten all joints. Clamps may also be used.

Also throughout the installation all traces of adhesive to the board surface must be cleaned off. A cotton cloth and regular changing of rinse water is necessary to prevent glue haze on the board surface.

The final row of boards will likely need to be cut lengthwise and again ensuring an even expansion gap to the recommend size is provided to the external wall. Wedges are also to be placed in the expansion gap to hold the final row of boards tight as the adhesive sets. When dry the wedges are removed.

It is also important throughout the installation to consider the overall floor area and where intermediate expansion joints and joints at doorways may need to be provided, with appropriate trims being used to permit floor expansion movement.

Interlocking (glueless) joint system installation

Where the flooring has an interlocking (glueless) joint system the process is similar to the T&G installation outlined above except that no adhesive is required. The choice of starting wall, possible need to cut lengthwise the first row of boards to provide an even expansion gap and staggering of joints etc. is all the same.

Some manufacturers suggest three rows of boards be laid. The first row laid by rotating the end joints together and subsequent two rows rotating the edge joints together and then using the provided blocks to gently tap end joints together. Once three rows are fitted this flooring section can be slid on the underlay to achieve the final correct positioning and expansion allowance spacings. The main body of the floor and possibly cutting of the final board are undertaken similarly.

6.5 Direct adhesive fix installation

A T&G profile that permits a sliding fit and allowing small movements at board joints is used for direct adhesive fix applications.

Aspects relating to the product chosen including its manufactured moisture content range, on-site storage and acclimatisation, the in-service environment, subfloor condition, underlay to be used, safety aspects and equipment needed to complete the installation should all have been considered and be in accordance with the manufacturer recommendations, prior to the point of floor installation. Similarly the points outline in section 7.1 should also have been considered.

Some general points with direct adhesive fixed flooring installation are as follows:–

Flooring manufacturers will often recommend a particular adhesive be used with their product and therefore it is important that such recommendations are followed as the properties of polyurethane adhesive differ between manufacturers. With floors on slabs an appropriate moisture vapour retarder compatible with the adhesive (generally of the same brand as the adhesive where applicable) will be specified. On plywood and particleboard subfloors no moisture vapour retarder is usually necessary as these subfloors should be within a suitable moisture range prior to floor installation. However, installers must still check the subfloor moisture conditions. (Problems often result from assuming prior trades have provided correct conditions)

It is also important to apply polyurethane adhesive in accordance with the flooring and adhesive manufacturers’ guidelines and particularly in terms of the trowel size, spread rate, open times, curing times and weather conditions that could affect bonding. Surface preparation and testing as outlined in Section 3 are also particularly important.

Floors are generally laid to a chalk line about 450mm out from either end of the starting wall. The exact distance being a multiple of the board widths plus the expansion allowance to the wall as recommended by the flooring manufacturer. However, consideration also needs to be given to walls that may undulate and rooms that are not square which may influence the positioning of the string line and necessitate cutting of the first row of boards lengthwise to suit. The required expansion allowance at walls needs to be maintained.

The first rows of boards should be installed, seated in the adhesive with the groove edge lined up to the string line and the tongue edge facing the starting wall. Longer and straighter boards being preferred for this row of boards. Note also that some manufacturers require board end T&G joints to be adhesive fixed with a PVA adhesive.

When laying it is usual to engage the end T&G joint with the side T&Gs of the boards as close as possible. The side T&Gs are then engaged with a minimal amount of sliding movement. This ensures minimal displacement of the adhesive and possibility of pull back from memory effects.

Laying from the first row of boards will initially commence toward the starting wall. This row of boards can be held in position with a sacrificial row of boards nailed to the subfloor on the groove side of the boards. The board to the starting wall, if not otherwise trimmed, will likely need the tongue removed to provide adequate expansion allowance.
Laying can then continue away from the starting wall with the same method as outlined above. It should be noted that working from on the flooring just laid should be avoided as it can create numerous drummy spots when the floor is completed. If unavoidable in some areas a kneeling board to distribute the weight should be used.

During installation the transfer of adhesive can be checked by removing smaller floor boards after laying and checking the back of the board. If adhesive skins and transfer is inadequate the bonding will be compromised. Some recommendations require the floor to be weighted to achieve even transfer. Weather conditions affect the open time and care is necessary not to spread the adhesive too far ahead of the work area.

Any adhesive on the board surface needs to be cleaned off during the laying with the cleaner recommended by the adhesive manufacturer and cleaning cloths need to be frequently changed to prevent an adhesive haze to the board surface.

During laying it should be continually checked that joints are tight, that the floor is aligned and that board lengths are chosen to achieve a staggered appearance with a minimum of 100mm but preferably with board ends 300mm to 500mm apart.

Heavy foot traffic should be avoided for at least 24 hours and it should be noted that at this time the adhesive will also not have fully cured. Even so it is permitted to lift heavier items of furniture or benches back into place after this time.

The final row of boards will likely need to be cut lengthwise and again ensuring an even expansion gap to the recommended size is provided to the external wall. Wedges are also to be placed in the expansion gap to hold the final row of boards tight as the adhesive cures. When dry the wedges are removed.

It is also important throughout the installation to consider the overall floor area and where intermediate expansion joints and joints at doorways, may need to be provided, with appropriate trims being used to permit floor expansion movement.

### 6.6 Other installation methods

The above outlines the most common forms of floor installation. Some products may also be suitable for installation by other methods such as mechanical fixing to a timber of sheet subfloors or mechanical fix to a batten system over concrete. At times floors are also adhesive fixed over ceramic tiles or similar. When laying on a subfloor over joists, with some flooring it is also preferred that boards are laid at right angles to the direction of the joists as this prevents the possibility of the visual effects from minor sagging of the subfloor between joists from being a concern. Procedures will be contained within the individual flooring manufacturer’s installation guides for these installations and such methods should only be used for the products intended by the manufacturer.

### 6.7 On completion

After the flooring has been laid, and in order to complete the installation, skirtings of sufficient size to cover expansion allowance provided at walls etc. need to be fitted and fixed to the walls. Where floors are laid with the skirting in place, a fillet mold is usually used to cover the expansion allowance. In some spaces elastomeric filler can be used.

When prefinished floating floors are completed they should be thoroughly cleaned using the appropriate cleaning products (see section 7) and any scuffing or minor scratches attended to prior to handover. At times minor imperfections may also be present in the floor and these can usually be filled with an appropriate colour matched filler or a hot wax repair. If the floor has been damaged and cannot be repaired to an acceptable condition, the individual board or area of flooring may need to be replaced.

Similarly the above applies to adhesive fixed floors and those that are sanded and coated on site. Depending on the individual installation, a period up to 10 days would be required for the adhesive to cure and for a sanding and coating process to be undertaken. Sanding and coating processes are outlined in ATFA publication ‘Timber Flooring’ where the general process is described. However, aspects that need to be noted are that both during the installation process of an adhesive fixed floor and then any subsequent sanding and coating, no one should walk on the floor except the contractors themselves. In addition actions such as just opening a door can introduce unwanted dust onto a freshly coated surface and should be avoided. Minor imperfections with site sanded and finished floors often occur but do not necessarily require remedial work.
7.0 Caring for your floor

7.1 General care

Engineered timber floors are considered to be easy to maintain but like all floor surfaces they do require regular cleaning and few precautionary practices to maintain their appearance and preserve their service life.

On a regular basis floors should be dry mopped with a static mop, soft bristle broom or by vacuum cleaning (provided a brush or felt head is used and any wheels can rotate freely). Ensure with such cleaning nothing hard rubs on the floor as it may mark it. These practices not only pick up any lint and dust but also grit that can be damaging to the floor surface. Similarly, if pets are to be inside it is necessary to ensure that nails are trimmed and paws clean, thereby not introducing excessive grit. Any spill needs to be wiped up as soon as it occurs. Failure to do so can dull or discolor the finish and if left for a long period can damage the flooring.

Rugs and floor mats are also effective in trapping grit at doorways, both inside and out, and reducing wear in high traffic areas. However do note that both the coatings and timber colour can change under the effect of UV light and that this can cause colour differences under rugs. For this reason it can be prudent to not use rugs for the first six months or so. Alternatively, moving rugs on a more frequent basis and at times furniture over this initial period and ensuring curtains and window coverings filter sunlight can assist in reducing these effects. Rugs should also not be rubber backed or have similar impervious backing. Not only can such products mar the floor’s finish but they can prevent the floor’s natural exchange of moisture vapour through the board surface. All rugs and floor mats also require regular cleaning.

Legs of moveable furniture such as dining room chairs need to have protective felt pads to prevent scratches from occurring. When moving heavy objects such as furniture or appliances they need to be lifted into position to prevent bruising or scratching of the floor surface. Footwear with high point loads such as stiletto heels will also damage timber floor surfaces and therefore management of this is necessary.

In addition to the above there are a number practices not appropriate for bamboo floors as follows. Do not use cleaning methods or products not designed for timber floors such as scouring pads or cleaners that may contain abrasives, soaps, waxes, ammonia or silicon. Specific timber floor cleaning products are available and should be used. Do not use steam mops (irrespective of what the product sales people may say) or any form of scrubbing machine. Do not use floor mats or rugs over heated subfloors.

7.2 Refurbishment

With many flooring products a maintenance coat may be used periodically, applied by the homeowner or maintenance personnel. These provide a sacrificial coating that protects the floor finish and can also mask scuffing and minor scratches. However in time it may be desired to fully refurbish the floor through buffing or sanding back and recoating. If the finish has not worn through to the timber surface, and this is quite likely with the coating additives often used, then the floor can usually be buffed back and recoated. Some floor products suit traditional coating systems but those with wear resistant additives generally require a specific coating available for pre-finished flooring and if not used, rejection and a poor appearance can result.

In other instances it may be desirable to sand back to bare timber, however it must first be ascertained that the flooring product has a sufficiently thick lamella or veneer for this to be possible. Other aspects such as the evenness of the floor surface would also need to be considered. Site sanded and finished floors generally provide a high standard of appearance but most contain some imperfections (e.g. dust particles and visual grain effects) not found in an original factory coated floorboard. Such imperfections, if minor in nature, are acceptable to the industry. The coating may also not be as long lasting as the factory finish and will therefore require attention a little more frequently.
8.0 Warranties

Most products are provided with warranties relating to the manufacture of the board and the coating system applied. The extent of the warranties also often differs between residential and commercial floors. In addition to this, warranties relating to the installation also need to be considered and purchasers need to determine what is covered with respect to this as it will relate to individual installers. It should not be assumed that because product manufacturer warranties are being provided, installation warranties necessarily apply.

Warranties relating to board manufacture are generally very specific in nature and only cover a manufacturing defect such as delamination of the veneer or lamella. A condition of warranties is often that boards are to be inspected for possible faults at the time of installation and therefore only defects that develop and are not visible at that time may be covered. Product warranties on all timber flooring do not cover ingress of moisture as the effects are well known and to be guarded against. Also when moisture ingress occurs through the likes of building and appliance leaks, insurance policies are available to cover such events.

However it is evident that many warranties do not cover changes to the product that can occur through humid conditions encountered both at the time of installation and when the floor is in service. Such aspects can significantly alter the appearance of the floor and controlling internal conditions can also be difficult. Nevertheless such circumstances can result in non-compliance with warranty conditions.

Non-compliance can include circumstances such as the dwelling not being permanently habited, the internal environment not being maintained within tight limits on humidity even in localities where moderate to higher humidity would be considered normal, flooring being laid in areas that could become wet and the effects of exposure to direct sunlight. Similarly, aspects relating to damage to the flooring during transport or installation are also not covered by product warranties.

In many instances where a floor may exhibit a high degree of crowning, raised joints, checking, squeaking or other visual effects from board shape changes, they are often influenced by environmental conditions and therefore it should be considered that they are not automatically covered by product warranties. Aspects relating to product moisture contents, product construction and profiling tolerance can also influence the way a floor performs and contribute to the above but this requires sufficient evidence which can be difficult to obtain.

Concerning coating system warranties, they relate to the coating system performance only and not aspects such as changes in the colour of the board or tone of the coating which often happens over time. Similarly, scratches, scuff marks and indentations are not covered. Aspects of gloss variation and wear that will occur with time particularly in high traffic areas are also not generally covered. Warranties therefore only relate to the original factory coating and generally only a defect in the coating system that, for example, could result in the likes of delamination of the coating.
9.0 Glossary of commonly used terms

**Acclimatisation** – Some product suppliers indicate that flooring should not be installed straight away after it is delivered to site. However with bamboo flooring, acclimatisation can have different meanings. In many instances it refers to storing the flooring in the installation environment in its boxes for a period so that it can become accustomed to the temperature within the dwelling. In a few instances acclimatisation may be referring to unpacking and equilibrating the flooring to the internal relative humidity. Also see relative humidity.

**Buckling** – This refers to a group of boards arching off the subfloor generally due to the expansion allowance provided at skirtings etc being exceeded. Also see expansion allowance.

**Carbonized** – Prior to manufacture into the flooring feedstock a preliminary pressure heat treatment can be applied which heats the sugar in the bamboo and results in a darkening in colour. This bamboo is often referred to as ‘coffee’ coloured.

**Checking** – This refers to fine splits in the surface coating and surface of the board.

**Cold press** – A manufacturing process whereby the feedstock beams of strand woven bamboo has the adhesive applied to the strands, is pressed into a beam and after this the beam is heated to set the adhesive.

**Construction joint** – At times concrete slabs are joined (e.g. house extensions) however if the joint is not properly sealed, moisture vapour or even moisture from capillary action can pass through such a joint and affect the flooring above. Installers need to be aware of the potential risks of construction joints, however work to appropriately seal these joints, unless specified, is the responsibility of others. Subfloor expansion joints and construction joints running parallel to the direction of laying should be mimicked in the engineered floor above.

**Cross linked PVA** – When T&G flooring is laid as a floating floor, adhesive is applied to board joints. This is usually PVA adhesive and when cross linked it becomes less susceptible to breaking down under the effects of heat and moisture from a spill or similar. See also tongue and groove and floating floor.

**Cupping** – This refers to boards that have a dished appearance across the width of the board resulting in board edges being higher than the centre of the board.

**dB** – Noise transmission through a floor is measured in decibels with the abbreviation dB. Most of us would notice a change of 3dB and a reduction of 10dB would sound about half as loud. Choice of underlay can affect the noise transmission through a floor but there are also many other factors that contribute, including the thickness of the slab subfloor. See also underlay and subfloor.

**Evaporative cooler** – These are generally associated with a rectangular box like structure fixed to the roof of a dwelling. When water is evaporated off a surface there is a cooling effect and it is on this principal that these units operate. They introduce cool higher humidity air into the dwelling and with high use without appropriate venting can raise the relative humidity in a dwelling, causing a moister internal environment. This type of air-conditioning is more common in drier climates. Also see refrigerative air-conditioner, relative humidity and in-service moisture content.

**Expansion allowance** – Due to the hygroscopic nature of bamboo flooring products, all floors require expansion allowance. With small floors this may only be required at the outer edges of the floor and be covered be skirtings or beading. However many floors will also require intermediate expansion allowance. This is often provided at doorways and also in larger floor areas. See also hygroscopic.

**Flatness** – It is important that the surfaces upon which floors are laid are flat. Flatness differs from how level a floor is. A floor can be flat, not undulate up and down but may not be level in that it slopes from one side of a room to the other.

**Grading** – This is a process of sorting boards based on the features such as gum veins and knots present in them. Therefore one grade of a specific name may have fewer and smaller features than another grade of a different name. Grading does cover board length or colour.

**Hardness** – In Australia timber hardness is a measure of a board’s resistance to indentation. The test undertaken is known as the Janka hardness test and it measures the force that it takes to press a steel ball a certain depth into the bamboo.
**Hot press** – A manufacturing process whereby the feedstock sheets of strand woven bamboo have the adhesive applied to the strands and is pressed with heating to set the adhesive.

**Hygroscopic** – A material that is hygroscopic will absorb water vapour from the air or release water vapour into the air depending on its moisture content and the relative humidity in the air. Both bamboo and concrete are hygroscopic materials. Also see relative humidity and moisture content.

**In-service moisture content** – The moisture content that bamboo attains is dependent on the relative humidity and temperature within a room. In naturally vented houses the average moisture content is generally a little less than in external undercover conditions. Heating and air-conditioning can have a significant effect on the average moisture content of a bamboo floor. In-service moisture content refers to the range of moisture contents the bamboo floor will experience as a result of changing internal conditions. Also see moisture content, relative humidity, refrigerative air-conditioner and evaporative.

**In-slab relative humidity** – The surface moisture in a slab may be assessed using a moisture meter, however to assess the moisture deeper in a slab and thus the possible future effect on a bamboo floor the measurement of relative humidity within the slab can provide additional guidance. This test method is growing in popularity. Also see moisture meter and relative humidity.

**Interlocking ‘glueless’ joint system** – This refers the jointing system where the profile machined along the edges and ends of boards enable installation without the need to glue the board joints. At the factory wax is at times applied to the joint to reduce possible squeaking from rubbing in the joints. Also see tongue and groove.

**Laminated bamboo** – This refers to boards where the manufacturing process involves cutting and machining small rectangular sections of bamboo and then gluing these together either vertically or horizontally to form the material from which floor boards are manufactured.

**Micro climate** – All house sites differ so even though weather patterns may relate to a specific locality, aspects such as whether the house is on a hill or in a gully can affect the performance of the floor. Micro climate refers to the effects specific to building location.

**Moisture content** – This is a measure of how much water a material such as bamboo, timber or concrete contains. At a particular relative humidity the moisture content of two hygroscopic materials will differ. At 60% relative humidity timber attains a moisture content of about 11% whereas with strand woven bamboo it is a few percent lower. Also see hygroscopic and relative humidity.

**Moisture meter** – Due to flooring and subfloor materials being hygroscopic, meters have been developed to assess the moisture content of these materials. Meters have their limitations and the interpretation of readings should be carried out by someone with experience. Also see hygroscopic and moisture content.

**Moisture retarding barrier** – Where the engineered floor is direct adhesive fixed to a slab this refers to an applied product over the slab where the purpose is to reduce moisture vapour transmission from the slab to a level that will not affect the flooring. Note that these are not moisture proofing membranes.

**Prefinished** – Many engineered floors are sold with the coating system already applied. If this is the case and the flooring after installation does not require sanding and coating then it is a prefinished product. Also see UV cured.

**Refrigerative air-conditioner** – Often referred to as reverse cycle, split system or ducted air-conditioning, this type of air-conditioning extracts water vapour from the air inside the building and drains this away outside. As a result, high use can reduce the relative humidity inside and cause a drier internal environment. This type of air-conditioning is more common in more humid climates. Also see evaporative cooler, relative humidity and in-service moisture content.

**Relative Humidity** – This is a measure of the capacity of the air to hold invisible water vapour at a particular temperature. Under high relative humidity conditions some of this water vapour can be absorbed by the flooring causing board expansion and under low relative humidity conditions water vapour can be released from the flooring back into the air causing board shrinkage. Relative humidity is expressed as a percentage (%) where 30% and below would represent very dry conditions and 80% and above very moist and humid conditions. Also see hygroscopic, stability and moisture content.

**Scuffing and scratching** – Although coatings provide a floor with a good wear-resistant surface they can mark with grit or objects drawn across them. More flexible coatings will tend to show dull marks know as scuffing and harder brittle coatings will tend to show scratch marks. All floors require normal care provisions.
**Stability** – In terms of timber and related flooring, a more stable flooring product is one which undergoes only small changes in its dimensions (width and length) as the result of moisture vapour uptake or loss from the air. As such expansion and shrinkage of the product in response to changing environmental conditions is small. Also see hygroscopic, relative humidity and moisture content.

**Strand woven bamboo** – This refers to boards where the manufacturing process involves converting the bamboo into strands which are then glued together under pressure to form a sheet or beam from which boards are cut and manufactured.

**Subfloor** – The term subfloor is the structural surface over which an engineered floor is laid. This can be concrete, particleboard and plywood or in some instances joists. Also see underlay.

**Tongue and Groove** – This is often abbreviated as T&G and refers to a board profile that slides together at edges and ends. When used with floating floors adhesive is applied to the joints. Also see glueless joint system.

**Underlay** – With floated floors it is necessary to provide a cushion between the flooring and subfloor. This is the underlay which is generally a thin foam but which often contains a moisture retarding barrier. Also see subfloor.

**UV cured** – When prefinished flooring is manufactured the coating system applied in the factory is cured by ultra violet light and as this is almost instant, boards can be handled immediately at the end of the coating line. This process enables wear resistant layers to be added to the coating system and provides a very high standard of finish. Also see prefinished.