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# TECHNICAL PUBLICATION

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## VENTILATION UNDER TIMBER FLOORS

The traditional usage of unseasoned or 'green' bearers and joists has stood Australian home builders in good stead for many years and with careful selection of timbers, attention to detail and sound building practices, timber strip or sheet floors laid over such a system have and will continue to provide excellent service for many years to come. However, with an increasing emphasis being placed on extracting the maximum value from our unique hardwoods and the development of new and better preservative treatments for our plantation softwood resource, the use of fully seasoned floor framing is attracting considerable interest among builders and homeowners alike.

There are a number of benefits associated with the use of fully seasoned timbers including:

- Greater strength and smaller end sections.
- Minimal shrinkage or other movement.
- Ease of handling - most is machined to a smooth finish.
- Finished to exacting tolerances.
- Usually grade branded.
- Economy of use - size can span greater distances with the provision of more usable subfloor space and resultant savings in the construction of supports.

### MOISTURE CONTENT

Any timber purporting to be seasoned, or creating the impression of being so, must, in accordance with the New South Wales Timber Marketing Act 1977, be within the range of 10-15% moisture content (m.c.) unless it is clearly agreed in writing between the buyer and seller



that some other level of moisture content is required. (This notification may be in the form of a written notation on a delivery docket or invoice etc.) A variation in moisture content may be required if the building is to be air-conditioned or if it is in an area with a particularly high or low relative humidity.

**Table 1.** Equilibrium moisture contents in different locations in New South Wales.

Location	Equilibrium moisture content (%)	
	Max	Min
Sydney	15	10
Bathurst	13	9
Broken Hill	12	7
Canberra	13	9
Coffs Harbour	15	13
Newcastle	14	11

If the moisture content of the timber to be used is at too great a variance with actual or expected local conditions, it cannot reasonably be expected to perform as it should. If for instance, timber strip flooring is laid and fixed with a low moisture content during a period of low relative humidity, there is every likelihood that when conditions return to normal, the timber will take up moisture and expand. Naturally, the same situation could easily be reversed. In general, longitudinal movement will always be negligible. While any changes to the board's thickness will usually be imperceptible and of little consequence in a flooring situation, the relative movement in the width of floor boards is usually critical and the wider the board the greater the potential for movement will be.

While there is no doubt that wider Tongue and Groove (T&G) strip flooring boards can look very attractive, unless their environment is carefully controlled, it is usually recommended that their width be limited to a maximum nominal size of 100 mm because of the movement likely in an uncontrolled environment.



Because of the chance of movement, it is generally recommended that solid timber flooring, that is T&G strip flooring and parquetry, be allowed to reach equilibrium with its intended surrounding atmosphere before being finally fixed into position. This is usually achieved in the case of strip flooring, by cutting the boards to their intended length and leaving them upside down on the joists for a period of at least two or three weeks before finally cramping and nailing them into position. Obviously the success or otherwise of this operation will depend very much upon the initial moisture content of the timber and the relative atmospheric conditions at the time. To take any guess work out of the decision to lightly or tightly cramp the boards it would be wise, if you have access to a moisture meter, to check the timbers' moisture content levels before finally laying. Alternatively, State Forests' Timber Inspection Service will, for a fee, check this for you.

**Note:** *If using a moisture meter, ensure that the appropriate differential allowance is made for the species of timber being checked.*

While the fixing of parquetry is considered a critical operation requiring considerable skill and exacting tolerances to be maintained, because there is little force applied in the operation and because of the short lengths involved, parquetry does not usually create the same fixing problems associated with strip flooring. Equally, sheet flooring such as particleboard and plywood, because of their physical structures, are not as prone to movement as solid timber and are often used as a stable substrate for other products.

The National Timber Framing Code, AS 1684-1992, requires that where strip flooring is fitted following the installation of walls, flooring parallel to those walls must be kept at least 12 mm clear of the wall plates to allow sufficient room for expansion under normal conditions. Where a floor exceeds 12 metres in width, provision for a centrally located expansion joint should be made. Where these provisions have been ignored or where abnormal conditions have existed it has been known for strip flooring to expand to such an extent that the flooring has lifted off the joists. In some instances bearers and joists have been forced to lift off piers, and walls, including masonry, have been pushed out of alignment.

#### **THE IMPORTANCE OF UNDERFLOOR VENTILATION**

The careful selection, laying and fixing of the floor at an appropriate moisture content for the area is of course extremely important but if, subsequently, adverse changes in the environment occur and are allowed to continue, problems can be expected.

While most people would never dream of pouring water over a timber floor, all too often the reverse is ignored until it is too late. The importance of ensuring the underside of the floor is kept dry cannot be over-emphasised. While the visible surface will normally be coated with appropriate sealing materials that will protect the boards from liquids and other moisture ingress, the underside will usually receive no such attention and will be left to the mercy of its environment.

While the ground under a building may appear to be dry, moisture will constantly evaporate from its surface. If inadequate air circulation is present to carry it away, this moisture will inevitably be absorbed by the dry timber until it again reaches a state of balance with its surrounding atmosphere. Naturally, if the underfloor conditions are damp or wet, the problem will be worse and could reach a stage where decay could occur in the timber members and musty odours and mould may become apparent within the building.

Adequate cross ventilation must be provided under any suspended floor to maintain not only the integrity of the structure but the health of the building and its occupants.

#### **SIGNS OF INADEQUATE VENTILATION**

Depending on the severity of the problem, inadequate ventilation may manifest itself in a number of ways.

##### **Odour and mould**

A generally musty smell will often be noticed in the underfloor space and in more severe cases it may be apparent within the building itself and be accompanied by mildew on internal walls. Usually this mould is to be found low on the walls and will normally be heavier behind furniture.

##### **Cupping of flooring**

As the underside of the floor boards absorb moisture, that face will tend to swell while the topside remains dry and stable. As the boards lift slightly at the edge it will cause a concave shape to appear across the board's top face. Looking across the floor towards the light will usually show up any surface undulations. Obviously, the more severe the conditions the more apparent the distortion will be. While the boards may be sanded flat again, it is recommended that before remedial action is taken with the floor, the cause should be identified and corrected. It is then advisable to wait as long as possible to see if the boards regain their original shape. While they may never completely flatten it is possible that

recovery will be sufficient that the distortion will be unnoticeable to all but the most critical inspection.

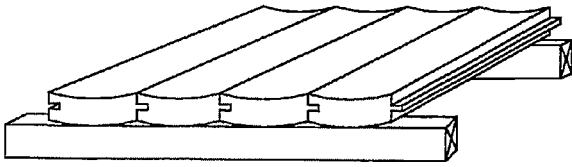


Figure 1. Cupping.

### Reverse cupping

In some instances cupping may be convex, that is the edges of the board are lower than the centre. The two most common causes for this phenomenon are firstly that the floor surface has been flooded causing a reverse action to the cupping or secondly that the floor has previously cupped and following sanding has regained most of its shape, thereby causing the edges to become lower than the centre because of the greater amount of material removed from them.

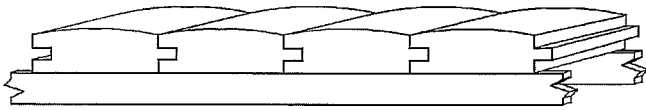


Figure 2. Reverse cupping.

### Doming or blown floors

Alternatively, the floor may react to excess moisture by lifting in a continuous curve, known as doming either pulling the nails from the joists or lifting the entire floor framing off its supports. Excessive springiness of the floor, particularly towards the centre of the room is usually a fair indication of this problem. Doming may occur during periods of excessively wet weather but, providing the nails have not pulled, when the weather conditions revert to normal or the underfloor conditions are corrected, the floor will usually return to normal.

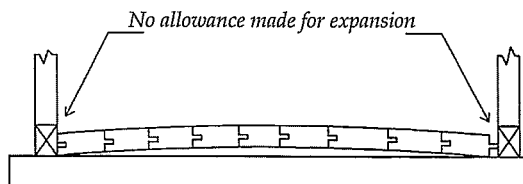


Figure 3. Doming or blown floor.

A blown floor on the other hand may be severe enough to actually force two or more boards up to form a peak or sawtooth effect. This is normally the result of insufficient expansion joints being provided in a large floor area and will often be more severe where a secret nail T&G profile

has been used because the boards are being held by only one nail on the tongue side of the board. Usually the only way to correct this problem is the removal of one or more boards, the insertion of expansion joints and the trimming and replacement of the removed boards.

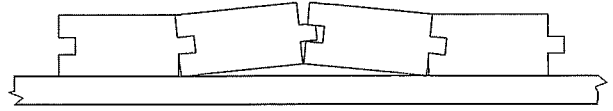


Figure 4. Peaking.

### Decay

Correctly designed and detailed timber is a permanent structural material that should be expected to last indefinitely. However, where adverse conditions exist and are allowed to continue, timber, like any other material, will probably not perform to expectations.

In most protected situations the permanency of timber is unquestioned but as noted earlier, if high humidity conditions in the underfloor area persist without correction and adequate ventilation is not provided, problems must be expected.

One of the greatest enemies of timber under damp conditions is fungal attack which, in the case of most untreated softwoods and low durability hardwoods, can reach a serious stage in only a relatively few years.

Where the moisture content of timber reaches around 20% and the temperature is above 5°C, fungal attack can often occur. However, ideal conditions exist within a temperature range of 25°-40°C and a moisture content of 25% and above. While fungal attack may not always be apparent, the existence of a musty odour referred to earlier is usually an indication that a problem exists.

Because of common building practices that existed until only recent years, particular care should be taken to inspect any timbers beneath, or adjoining bathrooms. Quite often fungi will be apparent on these timbers if there are any leakages. The use of a sharp probe, for instance a screwdriver, to test suspect timbers will often provide a useful indication of possible problems.

It is important to bear in mind though, that even good ventilation will be of little value if the underfloor area is allowed to remain wet because of poor drainage or seepage. Special care should be taken to ensure roof drainage and discharge are functioning correctly and that adequate subsoil drainage exists or is installed on the building's high side and that it is properly discharged away and to the low side of the building.

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## CONTROL MEASURES

It is apparent in Table 2 that if flooring timbers, and this will also be applicable to bearers and joists, bottom wall plates, and even the lower end of wall studs, have been seasoned (that is 10-15% mc) and are to remain within that range, the relative humidity must be maintained below 75%.

The amount of subfloor ventilator space required in domestic dwellings throughout Australia varies considerably according to topography and climate. The Building Code of Australia (BCA) no longer sets out any minimum requirements saying instead that subfloors must be well ventilated. In New South Wales it is recommended that subfloor ventilation should, under ideal conditions, be a minimum of 2100 mm<sup>2</sup> per lineal metre of external wall. This ventilator space must be positioned to provide adequate cross-flow and should be evenly disbursed throughout the perimeter of the building and any internal subfloor walls.

**Table 2.** Relationship between relative humidity and approximate moisture content at temperature of 21°C.

Relative humidity (%)	Approx moisture content (%)
40	8.0
50	10.5
60	11.5
70	13.5
75	15.0
80	17.5
90	22.0

With the widespread usage of timber frames and roof trusses, the incidence of internal load bearing walls is far less than it used to be which offers greater scope for efficient underfloor ventilation. Where full brick construction is employed with internal load bearing walls, additional care must be taken to ensure adequate cross ventilation. Whether brick or some other material, the same ventilation requirements exist as for timber, but in both instances the local approving authority should be consulted to ensure they have no special requirements.

In some instances, such as where underfloor insulation is installed, it may be preferable to reduce the air flow to minimise heat loss. In such cases the installation of a well sealed polythene membrane over the entire subfloor area will prevent excessive moisture rising into the

atmosphere. If a membrane is to be used, it is not essential to gain a perfect seal around piers and walls but care must be taken to ensure no free water finds its way to the top of the membrane or it will be useless. This method of reducing the requirements for ventilation may also be used in instances where it is impractical or impossible to provide adequate ventilation. This is often the case in some older homes and semi-detached houses.

If a moisture proof membrane is used, the underfloor area should be kept locked to prevent children and animals disturbing or damaging it.

### Ventilator types

The minimum suggested requirement for 2100 mm<sup>2</sup> of ventilator space per lineal metre of external wall is approximately equivalent to a row of unmortared brick joints of normal size all the way around the house. This, while being an unobtrusive way of providing the minimum requirement, means the gaps will only be some 7-10 mm in width. If, as is usually the case, maintenance of ventilator space is neglected, the likelihood of blockages from the original mortar, spiders' webs or other foreign material will soon render the available ventilation useless. More common these days is for the aggregation of the necessary gaps into groups of three or four, 50 mm wide spaces in the bricks. While that usually makes for easier bricklaying, another and better way of ensuring good cross ventilation is to provide a continuous row of open mortar joints of around 20-25 mm.



*Figure 5. Spaced brick ventilation.*

Where the foundation wall is easily accessible, the installation of additional vents in the form of cement framed bronze mesh ventilators offer a practical alternative. Available in various sizes, they are made to suit standard brick patterns and provide clear space of

up to 25,900 mm<sup>2</sup>. Where it is not practicable to provide additional natural ventilation, the installation of mechanical ventilators may solve the problem. These units are usually vented above the roof and generally work on the same principle as the wind driven roof space ventilators that are becoming increasingly popular. Because of site variations and the often substantial differences in performance of these mechanical units it is impossible to make any recommendations regarding brands, types or quantities required. The best advice would be to consult the various manufacturers or to engage a specialist in the field.

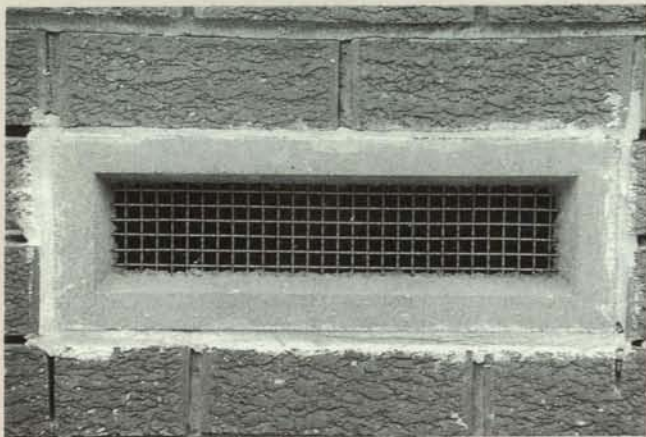


Figure 6. Bronze mesh ventilator.

**Note:** It is recommended that particular attention be paid to the installation of the vermin proof netting between brickwork and bottom plates since if vermin want to get into the subfloor area, one way or another they will.

### Underfloor hygiene

During construction it is probable that a considerable amount of builders' rubbish will accumulate beneath floor level. While it is the builders' responsibility to ensure all rubbish is removed before the handover of the building, some builders will inevitably be more conscientious than others. Be it a new house or an existing one, there is no substitute for checking it yourself. In addition to removing all rubbish, the soil should be levelled as much as possible. Unless there is reasonable space beneath the floor it should not be used as a general storage area for scraps and discards that may be attractive to rodents or termites. This, however, does not mean that material cannot be stored there, providing it does not substantially interfere with the intended cross flow of air.

### Concrete floors

While concrete slabs are a perfectly acceptable and proven form of construction on the right site, some precautions should be taken if purchasing a house or other building constructed on a concrete slab. Concrete is a permeable material and if moist ground conditions exist or if the slab is in any way breached such as by curing fractures or the provision of inadequate foundations, moisture, in one form or another, will rise to the surface with obvious results. The inevitability of this is recognised in the design and installation procedures for concrete slabs which require a specified waterproof membrane to be placed between the slab and the ground surface. While these installation procedures are quite detailed and provide more than sufficient protection when followed, unfortunately these membranes are often susceptible to mechanical damage from stones, steel reinforcement or workers' footwear. Therefore, particular attention should be paid to both the preliminary installation procedures and to ensuring sufficient perimeter drainage is in place before purchasing or occupying a house built on a concrete slab.

Even where moisture is prevented from entering from below, the common practice of building grass, paving or gardens up to or above the level of the slab to cover the unsightly appearance of the concrete is a recipe for disaster. A common point of entry for water and insect pests is the weepholes provided at the interface of brickwork and slab. Where these are covered, it is obvious they will not be able to function as intended.

If signs of dampness are detected soon after completion it should be realised that the accepted curing rate for concrete slabs is approximately one month per 25 mm of thickness. If floor coverings are laid before this time they will inevitably have an effect on the subsequent drying time and may absorb excess moisture from the slab.

If musty odours persist or if there are obvious signs of dampness that cannot be attributed to an identifiable source such as a leaking pipe or shower cubicle etc., subsoil moisture conditions could be checked together with drainage provisions. If these relatively simple measures do not provide a solution, expert assistance should be sought.