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Moisture Management of Timber Frame Construction



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1 Introduction

It is essential to protect buildings from prolonged excessive exposure to moisture during construction. Timber and wood products are hygroscopic materials, meaning they can absorb (take in) or adsorb (let out) water from their surroundings. Wood always balances its moisture content with its surroundings, irrespective of age.



Figure 1: Mould growth on timber frames and sheet flooring (Image: Meyer Timber).

This guide discusses the effects of timber exposure to excessive moisture, provides strategies to minimise moisture ingress during construction, and recommends remedial actions if necessary. The guide focuses on timber-framed buildings generally associated with residential construction. A separate WoodSolutions guide provides advice on moisture management for mass timber buildings.

2 Wood and Moisture

The wood in trees withstands decades of exposure to weather without significant deterioration or change. It is when we place it in service that we experience difficulties. The living tree requires large quantities of water to enable soil nutrients to be conveyed to the leaves for photosynthesis. Trees contain 40% to 200% water compared to their dry mass¹. This high moisture content in the wood protects the trees from a fungal attack.

Moisture content (MC) is a measure of how much water is contained in a piece of wood relative to the wood itself. Moisture content is expressed as a percentage and calculated by dividing the weight of water in the wood by the weight of that wood with no water, i.e. oven-dried.

When freshly harvested, the wood is saturated with water, mainly contained in the space in the wood cells and some combined within the cell's walls (see Figure 2a). However, wood is a hygroscopic material, which means it can release or absorb moisture to reach a moisture content at equilibrium with its surrounding environment. The freshly harvested wood wants to dry out, and the water contained within the cell space is lost first until there is no more. This point is termed the 'fibre saturation point'. Any further moisture within the wood is combined with the cell walls. Fibre Saturation Point varies for each timber species, generally around 26 to 28%. Radiant pine is a little higher at 29%¹ (see Figure 2b).

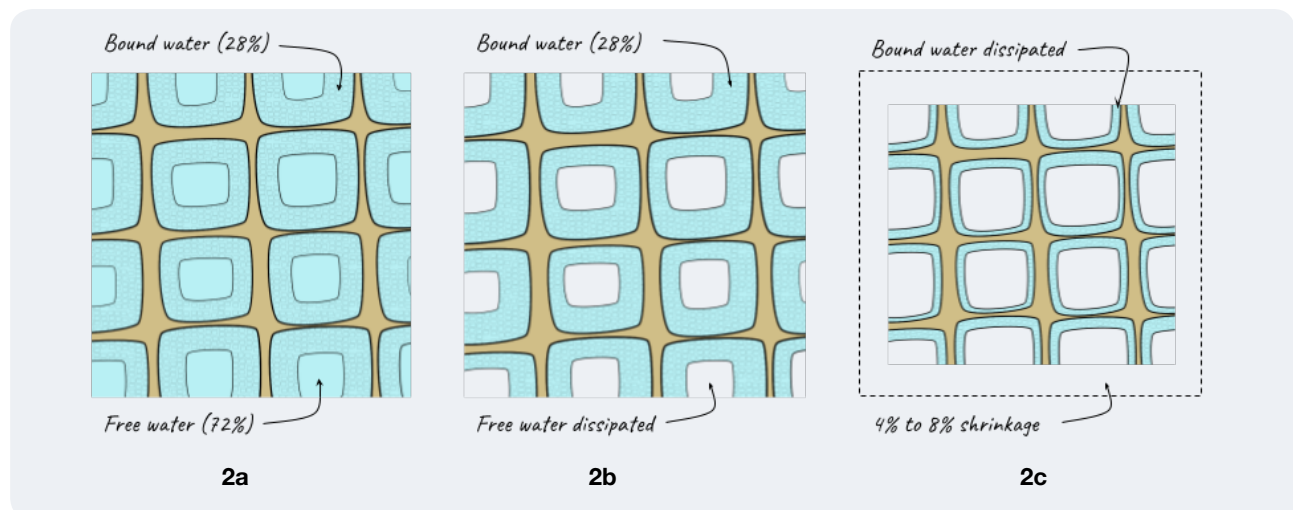


Figure 2: Water located in the timber structure at various moisture contents. (Image: TDA)

Wood continues to dry until it is balanced with the surrounding atmosphere's relative humidity, termed equilibrium moisture content. The water is in the form of water molecules that come from the wood's cell walls as it dries. This removal of the water molecules causes dimensional change to the timber, generally referred to as shrinkage (see Figure 2c). Before reaching the fibre saturation point, there is no dimensional change to the wood.

2.1 Where Timber Obtains Moisture

Timber can obtain moisture directly from liquids it is in touch with or water vapour in the atmosphere. Often, strategies for timber protection are to minimise liquid water. These strategies include surface coatings, sloping elements, drainage and coverings, which are discussed later. The aim is to shed the water away from the timber surface.

Atmospheric moisture is not prevented by these strategies, including coating. Timber adjusts its moisture content as the atmospheric moisture changes, termed relative humidity.

2.2 Relative Humidity and Wood

Relative humidity (RH) is the amount of moisture in the air as a percentage of the amount the air can hold. Warmer air can hold more moisture than cooler air, meaning that for a given amount of atmospheric moisture, the relative humidity is lower if the air is warmer than it would be if the air is cooler. Most people find an environment with a relative humidity between 40% and 60% to be the most comfortable. Humans tend to condition the environment until this ideal relative humidity is achieved.

The moisture content of wood not in direct weather exposure is directly related to the relative humidity of its surroundings. The moisture in the wood attempts to balance with the moisture in the air. Relative humidity between 40% and 60% and a temperature of 20°C results in wood likely to have a moisture content of 8-12% (see Figure 3). The ideal moisture content for timber used in service within a building is the average for the relative humidity range the wood finds itself. For unconditioned building environments, this is around 11-12%. For conditioned environments, this moisture content is usually a couple of percentage points lower, i.e. 9-11%.

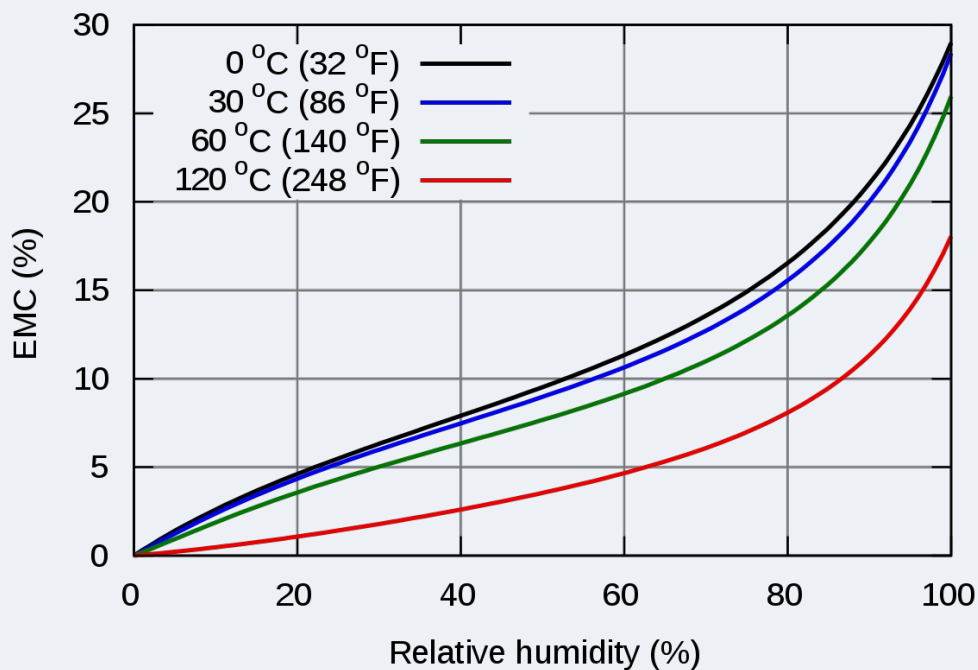


Figure 3: Moisture content of wood at different relative humidities (at 20°C). (Image: Wikipedia)

2.3 The Moisture Content of Timber at the Time of Sale

At the time of sale, moisture content for timber supplied for feature products, such as floors, must meet the following requirements:

- Hardwoods: 9–14% moisture content with an average of 11%²
- Softwoods: 9–14% moisture content with an average of 11%³
- White cypress: 10–15% moisture content with an average of 12%⁴

On the other hand, if structural timber is described as seasoned, for example, MGP or kiln-dried timber, it must have a moisture content of 15% or lower⁵. Structural sheet products may have much lower moisture content, depending on the manufacturing process and time since it was manufactured, i.e. allowed to balance with the surroundings.

Most timber sold, unless described as unseasoned or green timber, may have a targeted 11-12% moisture content, which is within the range of the moisture content from the ideal relative humidity.

2.3.1 Measuring moisture content of timber

Moisture content is generally measured by a meter, where two probes are pressed into the timber surface, and the electrical properties of the wood provide an estimate of the moisture content. Where a precise moisture content of the wood is required, the oven-dry method is used. This method is where the weight of the sample is compared to its weight after the sample is dried out in an oven.

Moisture meters

There are two types of meters, resistance and capacitance. The resistance meter measures timber's electrical resistance when a current flow is passed between two pins (see Figure 4). The resistance to passing a current reduces as the moisture in timber increases. The reading is influenced by the temperature and timber species; therefore, correction factors are applied to the reading. Modern meters can do this automatically.

Moisture meters with short, uninsulated probes can only estimate the surface moisture content, which may differ substantially from the average moisture content of the piece. Such meters should only be used to check surface moisture content, for example, before painting or installing.



Figure 4: Resistance moisture meter. (Image: TDA)

A capacitance meter measures an electrical property called the 'dielectric constant'. The meter produces an electric field within the timber on which the meter is positioned. The moisture content and the density of the timber affect this electrical property; consequently, the reading requires correction for density. Furthermore, the measurements can also be adversely affected by electrically conductive materials near the piece of wood, such as a steel beam underneath it.

At best, moisture meters estimate the moisture content at the point where they are applied. The moisture content may vary to some extent down its length and from the outer surfaces (case) to the centre (core). Moisture reading should be taken at least 300 mm from the end of the piece of timber and at least one-third in from the edge. They are also susceptible to some preservative-treated timber or salt environments, and corrections for these conditions are required.

For further information, see Technical Data Sheet 27 Measuring the Moisture Content of Timber, Timber Queensland⁶.

2.4 Shrinkage and Expansion

When wood dries below its fibre saturation point, water in wood is bound within the cell walls of the wood structure. Removing this water makes minor changes to the thickness of the cell walls. The accumulation of this reduction over thousands of cells reduces the thickness of the timber. This reduction in the wood cell walls causes little change in the longitudinal dimension, i.e. along the grain. However, across the grain, this is not the case. Wood movement across the grain depends on whether it is radial or tangential to the growth rings. Radial shrinkage is perpendicular to the growth rings, i.e. its movement is towards the tree's centre.

Tangential shrinkage is in the direction parallel to the growth rings. Its movement rate is usually twice that of the radial direction because radial shrinkage is partially restrained by medullary rays, i.e. fibres that run perpendicular to the growth rings.

The amount of movement in wood also depends on the wood species, the thickness of the timber, the part of the log from which the timber was cut, the initial moisture content, the rate of change of moisture and the environment in which the timber is placed.

Movement tends to be more pronounced for hardwoods than for softwoods. However, regardless of the species, appropriate allowances for movement must be made in detailing all timber used in service. Shrinkage effects are more significant for unseasoned timber allowed to dry in service. In this case, careful design is required to limit the effects of shrinkage, particularly around connections where splitting may occur.

Designers rarely know which cross-sectional dimension is radial and which is tangential, so shrinkage is often estimated for each cross-sectional dimension using the data for the tangential direction.

The Residential Timber Framing Standard AS 1684⁷ provides Unit Tangential Movement (%) for commonly available timber species. The Unit Tangential Movement is the dimensional percentage change for each 1% moisture content change between 3% moisture content and the fibre saturation point for the particular species. Table 1 provides the Unit Tangential Movement per cent for common structural timbers.

Table 1: Unit Tangential Movement per cent for common structural timbers

Timber Species	Unit Tangential Movement per cent
Blackbutt	0.37
Spotted gum	0.38
Radiata pine	0.27
Victorian Ash or Tasmanian Oak	0.36
Cypress pine	0.26

Note: The Unit Tangential Movement is based on AS 1684⁷

Example calculation

Dimensional change of a 90 x 45 radiata pine stud thickness from expected moisture content change due to exposure during construction, i.e. 4%.

Unit Tangential Movement per cent is 0.27 each 1% moisture content

$$\therefore 45 \times 0.27/100 \times 4 = 0.48 \text{ mm}$$

3 The Consequence of Excessive Wetting or Drying

Excessive wetting of timber can cause several issues: mould growth, decay and dimensional change, including checking and cracking. In addition, staining (water, iron and tannin), fasteners corrosion and algae growth may also occur; however, they are not discussed in this guide. For more information, refer to *WoodSolutions Technical Design Guide #53 Moisture Management of Mass Timber Construction*⁸.

Staining, mould and algae affect the surface appearance of the timber, while decay and fastener corrosion may affect the timber or element's strength. Dimensional change may cause appearance issues from cracks and checks to structural issues from differential movement or the splitting of the timber. The following discusses each in detail and provides recommended remediation.

3.1 Mould

Mould growth can be sooty black and unsightly, spreading rapidly in favourable circumstances, especially warm, humid weather (see Figure 5). Mould is a fungus and not a plant, and it produces spores. It feeds off the starches and sugars on the surface of the timber. Mould growth is superficial and will not influence the structural or durability of timber elements. Mould spores are always present outdoors and in buildings and are distributed by wind, insects, floods, animals and human activity. All buildings have a background concentration of settled spores.



Figure 5: Mould on the timber wall plate and sheet flooring. (Image: C. MacKenzie)

Mould will colonise on a wide variety of construction materials and building contents. Exposed soil within a building (e.g. a dirt subfloor space) is another area of potential mould growth. While some inorganic materials, such as fibreglass insulation or plaster and other masonry products, may not support mould growth, they may contain dirt or have surface coatings that can support growth.

Mould requires three key components to survive: a nutrient source or growth medium, a source of moisture, and favourable environmental conditions (e.g. temperature). Many construction materials contain enough organic material to cultivate mould when wet and within suitable temperatures. Mould is frequently found on the wet paper used in plasterboard wallboard and other materials with a high cellulose content, wood.

Most moulds reproduce by forming large numbers of spores. Active mould growth indicates continuing moisture problems, and it is recommended to be investigated. Mould growths occur on treated and untreated timber and on kiln-dried timber.

3.1.1 Mould growth on timber

Mould requires water, food and oxygen to grow. It also requires an environment with a temperature it can survive. Most moulds cannot grow below 4°C; the temperature of food is typically refrigerated. Mould grows best between 25° and 30°C, especially if the air is humid, consequently, wet summer conditions. While mould cannot spread without these conditions, its spores may survive in a dormant state until conditions are suitable.

Moulds are obligate aerobes, meaning they need oxygen to survive. Mould grows even at very low concentrations of oxygen, making it challenging to fight mould growth by limiting oxygen.

Wood has starches and sugars on the surface that can support mould growth. For mould growth to occur on timber, the moisture content must be above 19% for a week or more; to survive, the moisture content of the timber must stay between 20% and 28%⁹.

Their presence is related to temperature, humidity, wetting and the presence of atmospheric mould spores. Therefore, it is more likely to see mould during the hot and wetter months of the year or when the relative humidity is greater than 85% (see Figure 6).

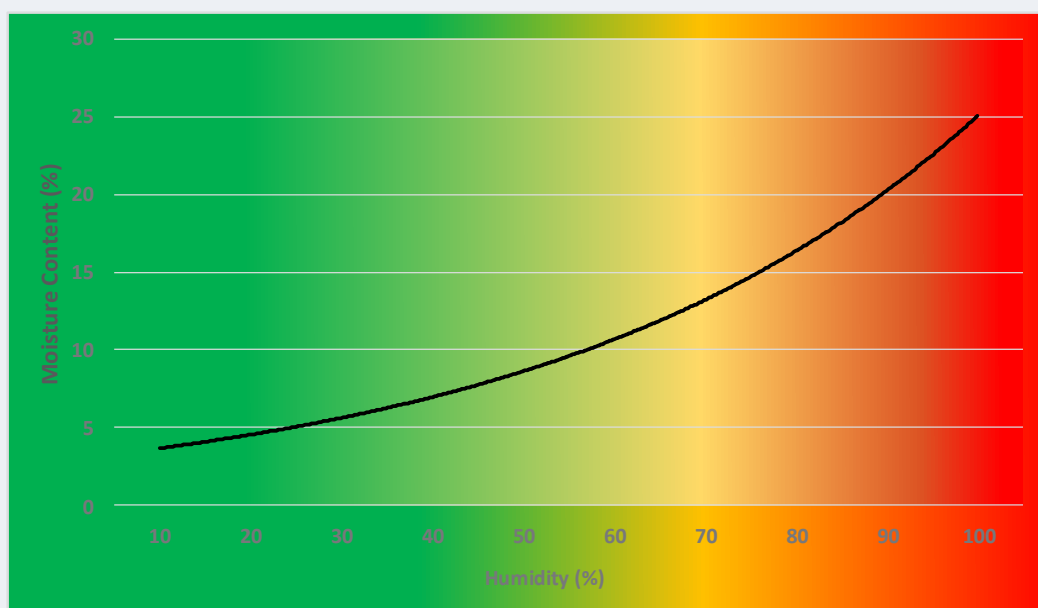


Figure 6: Timber moisture content, relative humidity and the risk of mould. (Image: TDA)

Moulds are generally black; however, some are green and should not be confused with algae, as discussed later. Moulds can occur on treated timber.

3.1.2 Effect of moulds on timber

Moulds on timber occur on the surface, and the timber is not weakened by their presence even when left for lengthy periods. Mould can be a health issue causing a runny or blocked nose, irritation of the eyes and skin and sometimes wheezing. For people with asthma, inhaling mould spores may cause an asthma attack. Very rarely, people may develop a severe mould infection, usually in the lungs.

In wet situations, e.g. floors, moulds can be slippery, which becomes a safety issue. With appropriate treatment, they don't become decay hazards.

3.1.3 Preventative measure

Although it is impossible to eliminate mould spores and nutrients from the construction process, it is possible to control the other element that promotes mould growth, mainly moisture. Mould needs moisture to grow; without excess water or humidity, mould growth may not occur. Limiting the free water on the construction site is the best strategy to minimise mould growth. Refer to Section 4 for strategies to reduce moisture on construction sites.

3.1.4 Remediation

While moulds do not affect the performance of the timber, the application of biocide products can kill the mould and restore the appearance of the timber. Some of these products take time to kill the mould; black mould can decompose for up to 4 to 6 months, while green growth takes up to two weeks. Alternatively, a timber restorer that contains oxalic acid or similar can be used.

Bleach is not recommended as it can't kill mould on porous surfaces, such as those made of wood. Even after applying bleach and wiping away mould from these surfaces, the mould may continue to grow beneath the surface and return to the area cleaned in a short time because mould spreads its roots deep into porous surfaces.

Also, high-pressure water cleaners are not recommended. The high-pressure cleaner can cause the wood fibres on the surface to be dislodged, destroying the milled surface appearance. Also, the high-pressure cleaner may increase the moisture content of the timber, promoting mould growth to return.

3.2 Decay

Wood provides a suitable substrate for wood-decaying fungus to grow, and the cellulose, lignin and other components of the cell walls and wood tissues provide suitable food. Some wood species are more naturally durable because they contain toxic substances to fungi. However, all sapwood in any timber species is susceptible to fungi as starches and sugar are present.

The moisture content essentially controls the development of fungi in wood. All wood-decaying fungi require moderate amounts of water for growth. Timber moisture content must be greater than the fibre saturation point of timber at approximately 28% (but can vary depending on the species) for wood-decaying fungi to develop. This condition must exist for more than a week for these fungi to develop and survive.

Fungi require a food supply and oxygen to survive, which is derived from the wood cells. The optimum temperature for fungal activity is between 24°C and 30°C. Fungal activity is dormant at 0°C and diminishes beyond 30°C.

If there should be insufficient moisture, after fungal growth has started, the fungi do not necessarily die but become dormant. Active growth can start again, sometimes years later, when sufficient moisture returns.

Fungi attacked wood left for an extended period may break down the timber cross-section and, consequently, the timber strength.

3.2.1 Brown, white and soft rot

There are three common types of fungi: brown, white and soft rots. Brown rot fungi attack the wood's cellulose, leaving the lignin, which is dark in colour. On the other hand, white-rot fungi concentrate their attack on the lignin, leaving the cellulose, which is light in colour. Soft rot fungi, like brown rot fungi, tend to attack the cell's cellulose. Wood affected by soft rot may change to a slightly darker colour but often remains very similar in colour to the original wood colour.

3.2.2 Preventative measures

Moisture control is the best way to limit fungal growth for timber used within a structure. Keeping the timber below 20% moisture content may prevent fungal growth. The presence of mould usually preempts conditions for fungal growth. Mould is likely to occur before decay fungi and is a sign that decay fungi growth could occur.

Where timber is expected to be in high moisture content environments, such as exterior environments, it is possible to eliminate the food supply by treating the timber with preservative treatments. Alternatively, use timber with high extractive contents or natural durability. The sapwood of all timber is susceptible to fungi attack. Refer to *WoodSolutions Technical Design Guide #5 Timber Service Life*¹⁰ for more information.

3.2.3 Remediation

Once the wood has decayed, there is no way to return it to its original state. In this situation, it is best to return the wood to conditions that are not conducive to decay to prevent further rot. Some brush-on preservatives such as copper naphthenate or boron may be used to prevent further decay.

Where the timber element has lost its strength carry capacity, it is recommended that the element is replaced. An assessment by a structural engineer is recommended for advice on any remedial action needed.

3.4.2 Blue stain in wood

Blue staining (see Figure 7) is another fungus that grows in sapwood and uses sapwood for food. It is not a stage of decay, although the conditions that favour blue staining also very often lead to infection with decay-producing fungi. Excepting toughness, blue staining has little effect on the strength of wood, and consequently, non-appearance grade timber elements may contain some blue stain components within them.

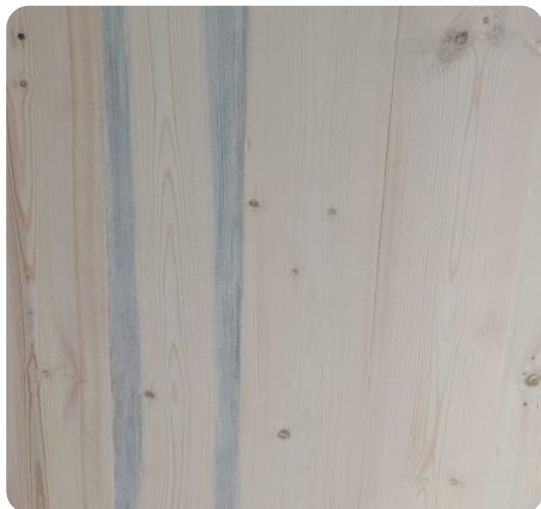


Figure 7: Blue stain laminations within CLT. (Image: TDA)

Blue staining is mentioned as it often has already stained the timber at the time of manufacture. Blue staining often appears during the harvesting and processing of wood into timber, particularly during the humid months of the year. As it has little effect on strength, blue-stained timber is often incorporated into non-visual products. The blue-stain fungi cannot grow in wood with a moisture content of less than 20% nor in wood where the cell cavities are full of water. Hence, staining can be prevented by drying freshly exposed surfaces to a moisture content below 20%.

3.5 Cracking and Surface Checking

Checks, cracks and splits in timbers are often misunderstood when assessing the condition of a structure. A check is the separation of wood fibres across the annual rings, and a crack is the separation of wood fibres across the annual rings but through the entire piece of wood (see Figure 8).



(a) Crack



(b) Surface checking



(c) Internal check

Figure 8: Check and cracks in timber. (Image: TDA)

During the drying-out process, any change in moisture content below the fibre saturation point results in a dimensional change to the timber. Moisture moves 10% to 25% faster along the grain than across it¹ because the moisture movement in the radial direction is 2-4 times faster than in the tangential direction. It is also likely to dry out quicker at the ends than the middle of the piece of timber.

Stresses develop in wood as a result of differential shrinkage, leading to checking, cracking and even cupping. Wood shrinks or expands approximately twice as much in the tangential direction of the annual rings compared to the radial direction. During the initial drying, the surface dries quicker than the interior, which causes differential stresses to develop within the timber element.

The weakest strength property in wood is tension perpendicular to the grain; drying stresses can result in a check or cracks that form in a radial direction across the annual rings. It is important to remember that as the wood dries, it becomes stronger. Also, visual stress grading rules allow checks up to 2.0 mm wide and 450-600 mm long, depending on structural grade. Therefore, the development of seasoning characteristics such as checking is normal and expected.

Although checking and cracking in timber elements are naturally occurring and expected, cracks sometimes occur for other reasons, such as timber restrained by metal connectors. Where this occurs, an assessment by a knowledgeable structural engineer is required.

3.3.1 Preventative measures

Managing moisture on the construction site may reduce the amount of checking and cracking. Furthermore, the proper drying and acclimatising of the structure may reduce checks and cracking (see Section 4.6).

3.3.2 Remediation

Where excessive checking or cracking occurs, wood fillers or putty can be used to fill in any check or cracks. Where significant spitting occurs, an assessment of its structural capacity is required, and the assessor may provide the appropriate remedial action if any is required.

4 Construction Moisture Management

One critical underlying component of the various elements discussed above is consistent: excessive moisture during the construction stage (see Figure 9). Strategies to manage excessive moisture may reduce the likelihood of these degradation agents occurring on timber elements.



Figure 9: Excessive water on a timber-framed construction site. (Image: WoodSolutions)

4.1 Moisture on Construction Sites

Figure 10 shows the moisture content of a timber stud on a north/east facing wall on the construction site of a building in Sydney. The moisture measurements were taken using a Point Moisture Measurement, 17 mm from the timber surface over 18 months, representing the building's construction, fit-out and occupation. The graph indicated that the timber elements in direct weather exposure had a moisture content of up to 18%, close to allowing mould to grow. As it was closed in, the moisture content fell to a low point of 10% during its occupation and dry summer conditions.

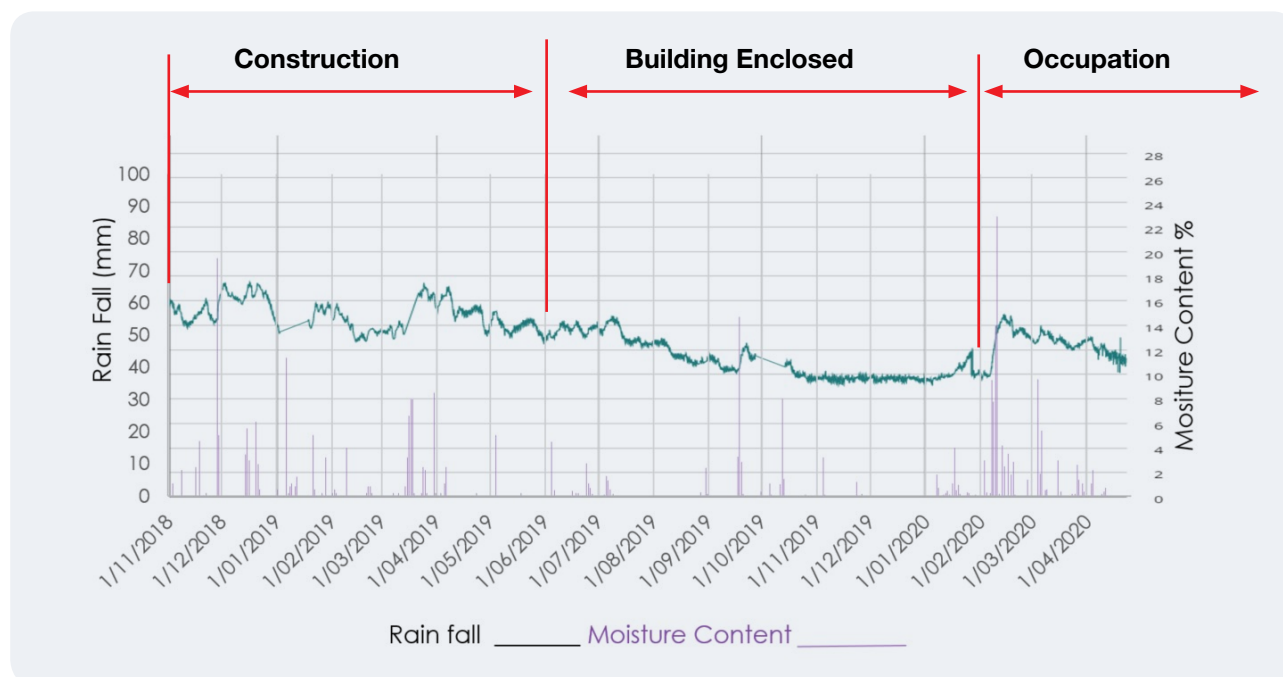


Figure 10: Rainfall data overlaid onto the moisture content of a wall stud. (Image: TDA¹¹)

Figure 10 also shows that the moisture content of the timber stud rose after each rainfall event, irrespective of whether the timber was undercover or exposed. The high moisture content of the covered timber is due to the atmospheric moisture change.

A timber structure is highly likely to be exposed to moisture during its construction phase, both from direct weather and atmospheric moisture. Without a careful, thought-out construction sequence, any additional moisture may create conditions conducive to supporting mould growth or fungal attack. The fundamental strategy is to stay dry enough to prevent mould spores from becoming active, even if the structure is exposed to water during the installation.

Although mould and fungi can grow any time of the year, it is in the humid hot months of the year that their presence is most likely, and during this time, extra precautions should be taken.

4.2 Construction Site Strategies and Principles

In most cases, timber elements arrive on a construction site near or at their equilibrium moisture content. It is the activities on the construction site that are responsible for introducing moisture back into the timber.

The primary way to prevent moisture from reaching a timber structure is for construction managers must realise that the installation and the covering of timber elements take precedence over other activities, particularly if the timber element has a decorative finish purpose.

The following principles and strategies should be applied to each building project.

- Minimise site work and time by utilising off-site prefabrication, including wall, roof and floor elements.
- Schedule timber installation during a relatively dry season, if possible.
- Coordinate material delivery for just-in-time installation to eliminate site storage needs. This includes sequencing the load so that each element that comes off the truck is in the order of assembly.
- Minimise the time of exposure to the elements, particularly for horizontal elements that allow liquid moisture to pool.
- Install the roof and exterior wall structure to complete the enclosure as early as practicable to protect the entire structure. The installation of exterior wall and roof membranes or sheet panels may provide temporary weather protection.
- The structure and each assembly should be designed to minimise the potential of ponding or trapping moisture by allowing it to drain and dry. The common area is the joints in timber.

On-site moisture management should be a part of the construction plan for the project and be a part of the responsibility of everyone on-site. On-site moisture management requires good communication, cooperation, and coordination among all the parties involved. The main strategy to achieve this can be described as the 3Ds – deflection, drainage and drying.

Deflection

Some shielding is applied to prevent water from reaching the timber surface. This shielding can come in several forms: wrapping or traps, tapes over joints or sealing end grain, temporary roofs, and enclosure of the buildings.

Drainage

The timber structure may receive some form of water during its installation. Timber can withstand this water for a short period. It's when water is present for an extended period that damage occurs. The strategy is to remove the water before it is able to pond. This could take the form of stormwater drains, drain points within the floors, or water-diverting strategies. If ponding water cannot be prevented, there must be a plan to remove it as soon as practicable.

Drying

It is likely that the moisture content of the structure will be elevated before the structure is enclosed in or a membrane is applied. The moisture content of the timber should be near its equilibrium moisture content or below 16%. Often timber structures are quick to construct, and the natural drying of the structure has not occurred before it needs to be enclosed. Therefore, a strategy is needed to reduce the moisture content by drying or other means. A hold point or inspection point is recommended to check the moisture content of the timber before linings and membranes are applied.

The following discusses areas where excessive moisture may come from and strategies to reduce moisture. It also discusses who is responsible for minimising excessive moisture from affecting the timber elements.

4.2.1 Deflection

One of the key strategies is to minimise the timber elements' contact with liquid water. On a construction site, there are many opportunities for this contact.

Site storage

As far as possible, plan the delivery of timber elements to minimise the time they are stored on-site. Where timber elements must be stored, they should be stored in a well-ventilated, drained and sheltered location, protected from direct exposure to the weather. The timber elements must be kept at least 150 mm off the ground using bearers (gluts/dunnage). The ground should be free of obstacles, debris and vegetation and well-drained so water does not settle. If the ground is continuously wet, place a waterproof membrane directly on the ground or construct a gravel pad. This recommendation includes concrete slabs where water may pond near or under the stack of timber.

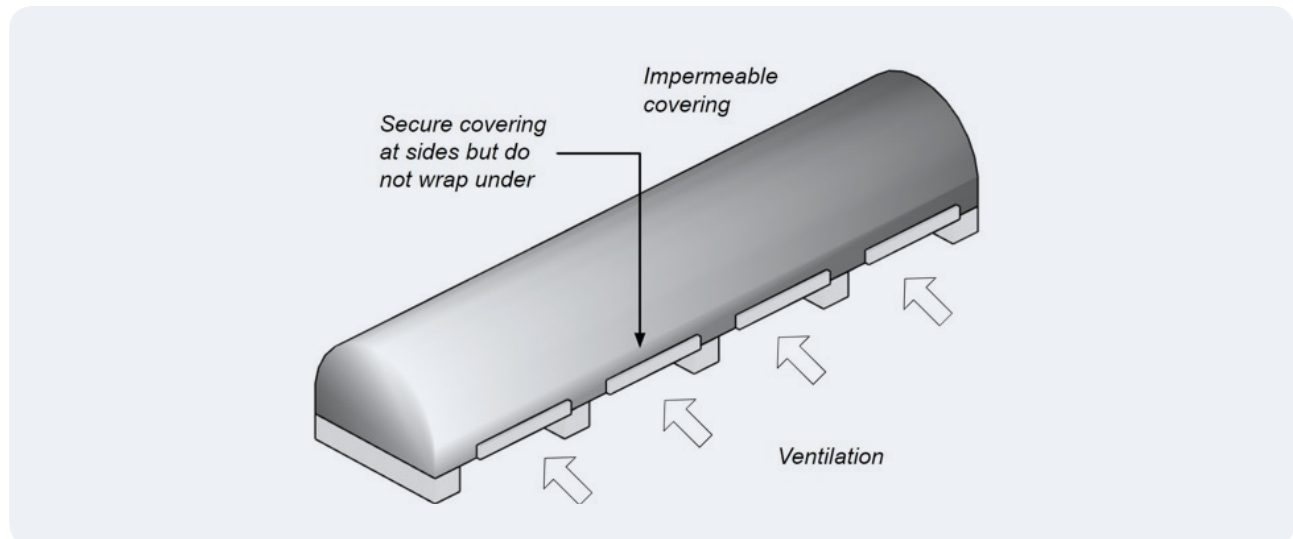


Figure 11: Stored timber elements. (Image credit: TDA)

If sheltered storage is unavailable, cover the timber elements with suitable impermeable covering or tarpaulins. Place the cover to preclude moisture while maintaining good air circulation in and around the timber. Do not tuck the wrap or trap under the stack of timber. If the wrap or tarp is damaged, make good with tape or remove and protect with a new impermeable covering or tarpaulins.

A vapour-permeable wrap is recommended when free air movement is not possible under a tarp or wrap. Impermeable wraps without adequate ventilation may cause condensation (see Figure 12). This situation often occurs when factory-wrapped timber elements are stored on construction sites.



Figure 12: Impermeable wraps without ventilation causing condensation. (Image: TDA)

Inspection Point: Monitor the moisture environment of the stored timber by regularly inspecting shelters and stored materials to assess moisture accumulation. Check the relative humidity of the environment under the wrap or tarp or take a moisture reading of the stored material. If the relative humidity is greater than 80% or the moisture content rises above 15%, then act to improve the ventilation of the storage area.

Reverse build

The early installation of the roof, windows and wall membranes allows the follow-on trades to rough-in earlier than current practices (see Figure 13). This can potentially decrease construction times significantly by reducing delays caused by bad weather and construction site moisture issues. This method is highly recommended when construction occurs during the hot and humid months of the year.

Many weeks of the construction program can be saved as issues caused by bad weather or delays in installing the façade don't delay the overall construction program. Once the building is weather tight, the internal fitout can proceed parallel to the exterior façade installation.



Figure 13: Reverse building practices weather-tight the building at an earlier stage. (Image: Bradford Insulation)

Sealing ends of large section timber

Due to their size, large section timber, such as glue-laminated timber or LVL, may dry out at different rates. A sealer should be applied to the ends of beams after cutting to size or trimming (see Figure 14).



Figure 14: Sarking-wrapped house. (Image: Pricewise Insulation)

4.3 Drainage

Even when the above defection strategies are in place, water may accumulate and require diversion from the building. Most issues occur when water is allowed to pond on the floor. Causes of this include wall framing that may have bottom plates in the door opening and blocking drainage. The bottom wall plate in the door frame is to aid in the stabilisation of the frame during transportation to the building site or during installation. In this case, the bottom plate at the door opening should be removed as soon as practicable after installation. Also, upstands such as hobs or parapets may interfere with drainage, and temporary drainage holes should be placed in hobs or parapets.

4.3.1 Structural panel flooring (particleboard, plywood and OSB)

Structural floor panels are designed for use in construction sites and are therefore expected to get wet during installation. Structural panel floors generally can be exposed for up to three months; however, there are conditions to be met, such as:

- Any ponding water should be moved as soon as practicable.
- Install drainage holes to all low points on the floor. A 3 mm maximum hole at 1 m spacing is recommended. Generally, the floor deflects under self-weight, so the mid-span of the floors may be lower than the floor supports. Drainage holes must be placed to avoid the supporting floor joists.

The above conditions are a part of installation practices for the structural sheet flooring called up in the National Construction Code (NCC) referenced Standard. Not adhering to these requirements may mean the floor does not meet the NCC deemed-to-satisfy solution.

Consider that the debris on a construction site may interfere with drainage. Debris may block drainage holes or accumulate against timber elements and bypass any end grain sealing (see Figure 15).



Figure 15: Debris accumulating against a timber wall, moisture by passing end protection.
(Image: XLam Australia)

4.3.2 Concrete slabs

It is particularly hard to divert water from suspended or slabs on the ground as the surface is often not level. In these situations, ponded water should be removed by a broom or vacuum as soon as practicable.

4.3.3 Stormwater management

Downpipes from the roof system are often not installed until the wall cladding is installed. In this situation, rainwater may be deflected into the building or flows back onto the floor. In these situations, temporary downpipes are recommended. Figure 16 shows a temporary plastic sheeting downpipe system.



Figure 16: Temporary downpipes. (Image: Rothoblaas)

4.4 Drying and Acclimatising the Building

Drying out the building before linings and covering are installed ensures that any damp timber is not locked into the structure. Furthermore, strategies to minimise checking/cracking, mainly when HVAC is commissioned, may reduce checking and cracking in the timber. Wet wood should be dried before it is closed in.

- Act to prevent further wetting prior to drying. Any liquid water on the surface should be removed by vacuuming or mopping.
- Drying occurs naturally when the ambient environment is favourable; that is, warm air with low relative humidity (e.g. <65%).
- Where the ambient environment is not ideal, or the drying needs to be accelerated for a quicker enclosure, accelerate the drying process by using fans, electric space heating (electrical heaters are preferred due to the less risk of construction fires) or dehumidifiers.
- For localised areas, such as joints and connection areas with severe wetting, blowing hot air may provide more efficient drying.
- Non-structural components, such as decorative coverings, plasterboard, insulation, and other coverings, must not be installed on damp timber. A hold point is recommended, where the moisture content is accessed, and approval from the contractor is given before sealing in the structure.

4.4.1 Protection against rapid drying

Aesthetical and dimensional issues such as excessive checking, cupping, and warping usually result from rapid drying, over-drying, or cyclic wetting and drying. They can occur during construction in a dry climate and in service, particularly when the space is suddenly heated or the HVAC is commissioned.

Dehumidifiers are typically employed to maintain the enclosed space's relative humidity level and slow down timber's drying. A closed space is needed to apply mechanical humidification during construction in a dry climate. Humidity control is essential for timber building in its first few years of service to allow the wood to adjust to the service environment slowly.

The slower the moisture content in the wood equalises with the moisture content in the air, the better. Where heating is applied to buildings, the following should be followed:

- Gradually increase the heat in the building over a 2-3 week period, up to average operating temperatures. This procedure may ensure a gradual change in the moisture content of the timber.
- Do not direct any forced air heating systems onto the timber.
- Regulate all heating units, remembering that hot air rises and temperatures at the ceiling will be higher than at the floor level.
- Maintain the average relative humidity in the building and monitor if necessary. Where high humidity is encountered, use a dehumidifier.

5 References

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