

Introduction

An understanding of the way in which moisture in timber affects in-service performance is important as it influences product selection and installation practices. This data sheet provides background information on the relationships between water and wood and where this knowledge should be applied. Through correct product selection and installation practices, subsequent in-service movement may be appropriately accommodated.

Water In Wood

In all common applications, timber contains moisture. Even timber that has been in service for 100 years will contain similar amounts of moisture to seasoned timber that has just been put into service. The reason for this is that the moisture in the air (humidity) maintains a certain level of moisture in the wood. The moisture present in freshly sawn (i.e. green) timber, straight from the log, is much higher and as a consequence of this, the air absorbs moisture from green timber until a balance is achieved.

Moisture Content

In the timber industry the amount of moisture present in timber or its moisture content is defined as the mass of water present in the timber divided by the mass of the timber with all water removed, expressed as a percentage. The mass (measured in grams or kilograms) of water present can be determined from the difference in the mass of the timber with water (initial mass) to the mass of timber with the water removed (oven dry mass). Hence the following equation is used to determine the moisture content of timber:-

$$\begin{aligned} \%mc &= \frac{\text{"mass of water present"}}{\text{"oven dry mass"}} \times 100\% \\ &= \frac{\text{"initial mass"} - \text{"oven dry mass"}}{\text{"oven dry mass"}} \times 100\% \end{aligned}$$

The structure of the cells in timber can be likened to a number of drinking straws glued together. If the straws were full of water it could be expected that the mass of water contained in the straws would be greater than the mass of the drinking straws alone. In such a case the moisture content as calculated above would exceed 100%. In a tree the moisture content may be as low as 40% but can be as high as 180%. Green off saw timber could therefore have moisture contents of 180%, which means the timber contains 1.8 kg of water for every 1.0 kg of dry timber that is present. In softwoods such as radiata pine and Araucaria average moisture contents of 180 % or more often occur. In many of our common hardwoods the moisture content may be no greater than 70%. Cypress, a softwood that grows in drier areas, may only have average green moisture contents of 45%. There can also be sizeable variations in moisture content between the outer sapwood of a tree to the inner heartwood.

The Drying of Timber

Seasoning is the process by which moisture is removed from timber (i.e. drying) and green timber may be either air dried or kiln dried or a combination of both. Timber that is stacked to allow air movement between each layer of timber can be air dried by leaving it out in the open for some months or it can be dried more quickly in the controlled conditions of a kiln. When we refer to seasoned timber, we are usually referring to timber that has moisture contents in the range from 9% to 14%. This range has been chosen because timber in coastal Australia will usually remain within this moisture content range, when used internally.

Whether timber is dried by the air or in a kiln there is always a small variation in the moisture contents of individual boards (usually about 5%). Due to these variations, some boards will take up moisture from the air after being put into service, while others may lose moisture. When timber takes up moisture it expands and when it loses moisture it shrinks. The small moisture variations present at the time of manufacture therefore translate into small differences in board widths, as board moisture contents adjust to be in balance with the humidity in the air.

The Effects on Timber Properties resulting from Drying

Although some products are manufactured from green timber, it is necessary to dry timber for many applications. When timber is dried, a number of benefits are achieved as follows:-

- greater dimensional stability with the timber less prone to distortion and smaller shrinkage gaps in applications such as flooring.
- less susceptible to insect attack and prevention from fungal attack providing the timber remains dry
- improved strength and stiffness properties enabling the timber to take higher loads with less deflection.
- reduced weight making it lighter to handle
- better machining characteristics providing a smoother machined surface
- acceptance of a wider range of glues and finishes
- ability to accept preservative and other treatments

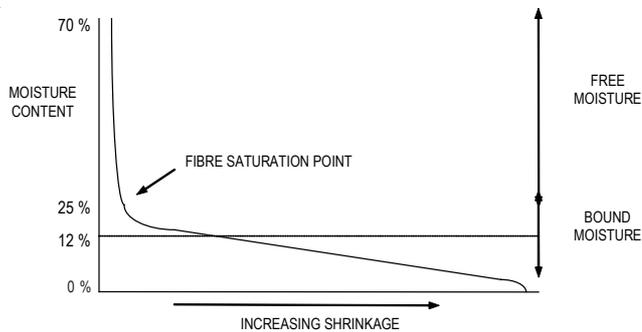
It is for these reasons that much of the timber used for both internal and external applications has been dried.

Movement in Timber with a Change in Moisture Content

The cell structure of wood has been likened to a number of drinking straws that are glued together. With regard to this, water in wood resides both within the "straws" (called free water) and in the walls of the "straws" (bound water). As indicated above, the moisture content in living trees will vary greatly depending on the species, age of the tree and location in which it is grown. However, no matter what the initial moisture content is of the wood in the trees, shrinkage in timber is minimal until

the moisture content reaches approximately 25%. At this level much of the free water has been removed and it is from this point (called the fibre saturation point) that there becomes a significant reduction in the bound water tied up in the cell walls. Associated with this, the cell walls begin to shrink and we observe shrinkage in timber. This relationship is shown diagrammatically in the graph in Figure 1.

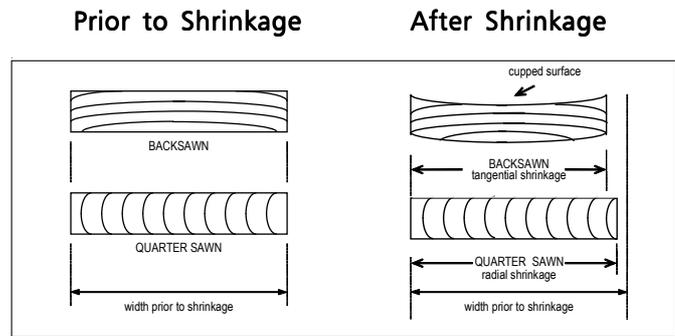
Figure 1



Within the sawmilling industry, boards are referred to as being either backsawn or quartersawn and the movement characteristics of each is quite different. In a backsawn board the angle of the growth rings on the end section to the wide face is less than 45 degrees. In quarter sawn boards this angle is greater than 45 degrees. (Refer to Figure 2). Backsawn boards are often valued for the "figure" that appears on the surface of the timber and with backsawing the amount of usable timber recovered from the tree is also usually greater. However, backsawn boards can be expected to shrink in width more than a quarter sawn board and due to the angle of the growth rings, backsawn boards will have an inherent tendency to cup when they dry, as shown in Figure 2.

The amount of shrinkage that occurs radially (i.e. in a direction that radiates out from the center of the log) differs from that occurring tangentially (at right angles to the radial direction). Therefore, in a backsawn floorboard the cover width will vary as a result of tangential movement and in a quartersawn floorboard the cover width will vary from radial movement.

Figure 2



A useful measure of movement is what is termed the "unit tangential movement" (U.T.M.). This is the percentage dimensional change for each 1% change in moisture content between 3% and the fibre saturation point for the particular species. For example Brush box has a U.T.M. of 0.38. Therefore a 3% increase in moisture content, could on average be expected to cause an 80 mm wide backsawn floor board to increase in size by

$$0.38 \times 3\% \times 80/100 = 0.9 \text{ mm.}$$

When dealing with seasoned timber, the U.T.M. maybe used to estimate anticipated movement however actual movement is often less than the estimate, due to the presence of quartersawn material and with regard to applications such as flooring, some compression of the timber often occurs. When working with unseasoned products such as hardwood floor joists, figures relating to the shrinkage from unseasoned to 12% moisture content are of greater importance.

Shrinkage rates for some common Australian species are provided in Table 1. The figures in each class represent the average shrinkage that occurs from unseasoned to 12% moisture content. Also included in the table are the U.T.M. figures for each of these species.

Table 1

Very low Tan. 0% - 3.5% Rad. 0% - 2.0%	Low Tan. 3.5% - 5.0% Rad. 2% - 3.0%	Medium Tan. 5.0% - 6.5% Rad. 3.0% - 4.0%	High Tan. 6.5% - 8.0% Rad. 4.0% - 5.0%	Very High Tan. > 8% Rad. > 5.0%
White Cypress (0.26)	Hoop pine (0.23) Slash pine (0.30)	Radiata pine (0.27) Spotted gum (0.38) Tallowood (0.37) Red ironbark (0.37)	Blackbutt (0.37) Jarrah (0.30) Rose gum (0.30)	Brush box (0.38) Victorian ash (0.36) Forest red gum (0.34) Sydney blue gum (0.35) Tasmanian Oak (0.36)



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