UDC 674.04
UDC 847

TECHNICAL PUBLICATION

Published 1968 (P. E. Marshall)
Revised 1976
Reprinted 1979, 1982, 1984
Reprinted 1991

ISBN 0 7240 5021 3
ISSN 0155—7548

Seasoning of Timber

Revised by A. LAMOND and J. HARTLEY

Seasoning of Timber

From day to day, most people have some contact with "seasoned" timber. From childhood days – wooden cots and toys, to school desks and, eventually, to wooden furniture and flooring in homes or places of employment – seasoned timber is to be found. Yet how many people really understand what seasoned timber is?

Only when cracks appear in furniture or floor, or when a door shows some degree of warping, is any thought given to this concept. It is to be regretted that even some people associated with the timber trade have little knowledge of what seasoned timber is and the best method of obtaining it.

What is "seasoned" timber?

The process of drying out the water from "wet" or "green" timber is termed "seasoning", or more simply "drying". Water is just as essential to the life of a tree as it is for all living matter. Together with the various minerals, it enters through the roots of the tree and is carried in the sapwood – the outer woody part – to the leaves. The food, that is the sugars and starch, are made in the leaves by photosynthesis and are transported in solution down the inner bark to the growing cells. The whole trunk of the tree is made up of cells, which are like small tubes, having walls of cellulose and a more or less hollow cavity filled with water and other materials known as sap. Consequently, when the tree is felled and the resulting log is sawn into timber, the sawn sections consist of innumerable small cells containing water. Drying the moisture out of wood enhances its properties to such an extent that the resulting timber is given the special name "seasoned" rather than "dried" although the terms are identical.

Moisture content

In order to understand what is meant by seasoned timber the term "moisture content" must be understood. This is simply the weight of water contained in a piece of timber compared with the weight of actual woody substance in the same piece. This is usually expressed as a percentage.

Expressed as a formula:

$$\text{Moisture content} = \frac{\text{Weight of Water}}{\text{Weight of wood substance}} \times 100 \text{ per cent}$$

Consider an ordinary sponge. This could weight only 100 g when dry, but when it is saturated with water it could weight 500 g. Its saturated moisture content could then be said to be $\frac{400}{100} \times 100$ per cent or 400 per cent. In other words it holds four times its own weight in water.

The green moisture content, that is the moisture content of a freshly sawn log, varies with the density of timber. Balsa, a very light porous timber, can have a green moisture content of 400 per cent, but ironbark, a very heavy timber, has a green moisture content of only about 40 per cent. In ironbark, there is so much woody tissue that there is very little free space to hold water. This water not only is contained in the hollow spaces in the woody cells (i.e. in the cell cavities) but also saturates the walls of the cells.

"Free" and "Bound" moisture

"Free moisture" is the name given to the water in the cell cavities in timber, and the moisture saturating the cell walls is termed the "bound" or "combined" moisture. Although the moisture is exactly the same in either position, its effect on the timber is quite different. As timber dries, the free water evaporates first, and the effect produced is principally a loss of weight. As the bound water is removed, however, the properties of the timber become noticeably changed.

Fibre saturation point

As the free moisture leaves the cell cavity, it will eventually become empty, leaving the cell wall still saturated. This is such an important stage in the drying that it is given a special name, and the term is "fibre saturation point". For most timbers the moisture content at the fibre saturation point lies between 21 and 33 per cent.

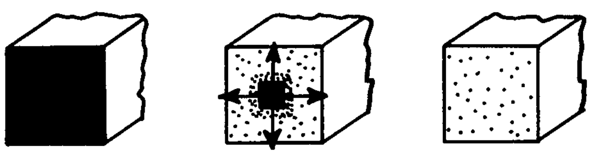
It should be noted that the fibre saturation point strictly refers to the moisture content of each individual cell and not the piece of timber as a whole. For example, consider the drying of a piece of board 100 mm × 25 mm, such as a floorboard. If it is hardwood, tallowwood or brush box, for example, its green moisture content when sawn would lie within the range of 50 to 70 per cent.

On being exposed to the air, the outside section of the board will dry first. Hence the cells in the outer 1 mm, say, will dry down to the fibre saturation point before the centre of the board has even started to dry. Although the moisture content of the outer section or "case" of the board may be about 21 to 33 per cent, the moisture content of the centre or "core" will still be the same as it was when the board was first sawn. The average moisture content of the whole piece, including both the core and the case, will still be close to the initial green moisture content. When the moisture content of timber is specified, it is always the average moisture content which is considered.

Moisture gradient

Because timber dries from the outside to the centre all commercial sizes of timber have a lower moisture content on the outside (case) than the core, when being seasoned. This difference is called the "moisture gradient" through the piece of timber, and it is always present when timber is being dried. Moisture flows from a wetter to a drier position and the gradient results in the core eventually drying out.

HOW TIMBER DRIES



1. GREEN 2. DRYING 3. SEASONED

Equilibrium moisture content

Considering again the drying of the pieces of flooring, the case of this timber dries to the fibre saturation point, and still continues to dry. As the case dries so does the core, but because the moisture has to travel further through the timber, it dries more slowly than the case.

Timber does not dry to a state of zero moisture content, unless placed in an oven kept at a temperature above the boiling point of water. Timber in use will be exposed to air, which always contains some moisture. The quantity of moisture in air is a measure of its humidity. The moisture content of timber in service depends on the relative humidity of the air surrounding it. As the humidity rises and falls, so does the moisture content of timber. Table 1 shows the relationship between relative humidity and the moisture content of timber.

TABLE 1

This gives Equilibrium Moisture Content of timber at various Relative Humidities at 20° C.

Relative Humidity	Moisture Content	Relative Humidity	Moisture Content
(per cent)	(per cent)	(per cent)	(per cent)
10	2.6	60	11.0
20	4.6	70	13.2
30	6.2	80	16.1
40	7.8	90	21.0
50	9.2		

The piece of timber will eventually dry until the moisture content of the core reaches approximately that of the case. If the timber is used indoors and not exposed directly to the weather, its moisture content from then on will fluctuate only a few per cent following changes in relative humidity. When timber has dried to this state, it is said to be at its equilibrium moisture content (e.m.c.) and is fully seasoned. For indoor situations in most of New South Wales, the moisture content of seasoned timber will vary between the limits of 10 to 15 per cent.

Hence, any timber dried to within these limits can be said to be adequately seasoned. In coastal areas, seasoned timber will maintain a moisture content of mainly 12 to 15 per cent, though in the very dry western areas of New South Wales such as Broken Hill, timber will dry down to approximately 7 per cent moisture content during summer.

It has also been found that in air-conditioned buildings timber should be seasoned to the low side of the range, that is, about 10 per cent. In these buildings, the relative humidity is usually kept low, and when the air is heated in winter time, the moisture content of the timber in such buildings drops to about 8 per cent. In summer, when no heating is required, the relative humidity of the air is higher and the moisture content rises to between 11 and 12 per cent. Therefore attention should be paid to the location of the timber in order to determine which moisture content would give the best results.

Why is timber seasoned?

Seasoning timber causes many changes in its properties, and in practically every case the change is an improvement. There is only one principal disadvantage in drying timber, namely, the loss in volume due to shrinkage. However, by a correct understanding of the shrinkage of timber this effect can be minimized, and timber can then be confidently used without fear of adverse behaviour subsequently in service.

Shrinkage of timber

All timber shrinks to some extent as it dries, resulting in a direct loss in volume. It should be noted that shrinkage is a direct cause of the cracks that occur on the surface or ends of sawn timber and is also the primary cause of the warping which sometimes occurs.

It was mentioned earlier that loss of free water has no effect on the timber except to make it lighter. When the combined moisture starts to dry from the cell walls the physical properties of timber start to change.

As timber dries below the fibre saturation point, it commences to shrink. The walls of the cells are made of long chains of cellulose molecules which, under an electron microscope, look like threads of cotton and which are named "microfibrils". These are saturated when the timber is green and the water molecules (that is, the "bound" water) keep these threads of microfibrils apart. As the water is removed by drying, the fibrils come closer together. Although the movement is minute in each cell the overall result is the shrinkage of the piece of timber. This shrinkage continues until the timber reaches e.m.c. For the rest of the life of the timber, as the moisture content changes slightly with the variations in relative humidity the timber continually shrinks and swells, but only to a small degree.

This small "movement" of timber, as it is termed, is occasionally observed in damp weather as the slight swelling causing sticking of drawers, windows or doors, but this effect disappears when the weather improves and the timber shrinks again. A fine shaving taken off the area that is binding will eliminate this small inconvenience.

Basically, shrinkage of timber varies in the three different directions of the tree, as shown diagrammatically. It shrinks very little along its length, of the order of only 0.1 per cent, that is, 1 mm per metre. In some cases a slight longitudinal swelling may occur but this is comparatively rare. Occasionally, a higher length shrinkage of up to 1 per cent can occur if the timber contains "reaction" wood, but this is also comparatively rare. A higher length shrinkage than normal will also occur if the timber has a large proportion of sloping grain (explained below) such as cross-grain and curly grain. The shrinkage in width will depend on how the board is sawn from the log. If it is quarter sawn, that is, in a radial direction, at right angles to the growth rings, its shrinkage would be roughly half of that if it is back sawn or sawn in a direction tangential to the rings.

THE SHRINKAGE OF TIMBER

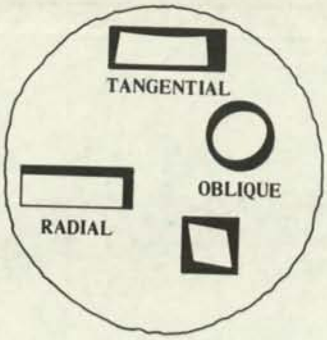


TABLE 2

The shrinkage of some relatively common timbers from green to 12 per cent moisture content.

Species	Radial Shrinkage (per cent)	Tangential Shrinkage (per cent)
Tallowwood	4.0	6.1
Blackbutt	4.6	7.6
Brush box	4.9	8.5
Sydney blue gum	5.8	7.9
Grey ironbark	4.0	7.0
Coachwood	3.7	7.0
Cypress pine	2.6	2.6
Radiata pine	1.7	3.2
Douglas fir	3.5	5.5
Teak	1.2	2.2
Redwood	1.3	2.2
Alpine ash	3.1	6.0
Spotted gum	4.5	6.5

Formation of checks

Because timber dries from the outside, it can be appreciated that the shrinkage of timber is a gradual process. The case section of a piece of timber can have a moisture content below the fibre saturation point (f.s.p.), while the core is still far above it. Hence some shrinkage will have taken place in the case, but not yet in the core.

This differential shrinkage leads to the production of forces or stresses in the timber. In particular, during the early stage of drying when the case is fairly dry and the core is at a high moisture content, "tension stress" is induced in the case because of the different shrinkage. If this stress is severe enough, it can be sufficient to rupture the surface of the timber, leading to the formation of surface checks or cracks.

Alternatively, in the final stages of drying, when the core shrinks the "core tension stress" is pulling the case inwards, and this tends to close up the surface checks. However, if this core stress is great enough, it can be sufficient to rupture the inside of the piece of timber, and produce internal checks, such as are shown in figure 1. In some species a phenomenon known as collapse can occur. Individual cells become flattened similarly to the way a drinking straw flattens if it is sucked when the far end is blocked. This causes a large and irregular shrinkage of the cross-section of the piece of wood, typically with the faces hollowed. It can also cause internal checking or honeycombing – separations of the wood fibres in the interior of the piece resulting in open splits or holes running along the grain. Steaming the wood when it is below the f.s.p. (known as reconditioning) removes most of the collapse shrinkage and distortion, and collapse will not recur unless the wood is wetted and its moisture content raised above the f.s.p.

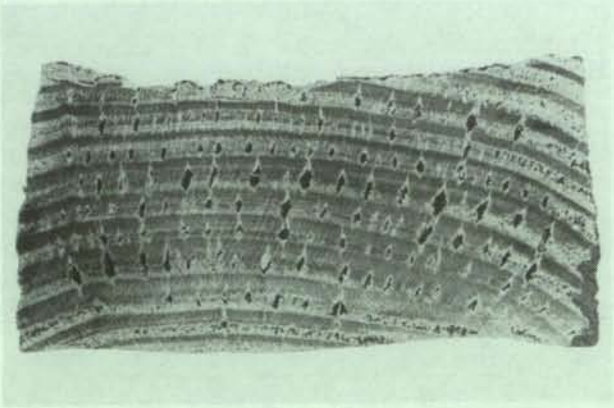


Figure 1

Severe internal checking (named "honeycomb") caused by rapid drying of timber. (SC2291.)

Warping of timber

Timber often contains "sloping" grain, forms of which are described as "cross" grain, "curly" grain or "spiral" grain. For example, where a knot occurs, the grain of timber deviates quite markedly from the direction of length of the tree resulting in sloping grain. Some timbers such as brush box often contain a large proportion of curly grain as a natural feature, where the grain direction is sharply inclined at different angles along the length of the tree.

During the drying of straight-grained timber, the shrinkage is uniform and at right angles to the length of the piece. When the timber contains curly grain, it shrinks at right angles to the grain direction, but as this is inclined at different angles to the length of the board, this variable shrinkage can cause it to warp. Timber containing spiral grain, where the direction of the grain follows around the tree like a corkscrew, will tend to twist during drying. Warping can be induced by drying timber unevenly. A piece of green timber with one face exposed to the sun will "cup" as a result of the faster drying (and earlier shrinkage) of the top surface. Such fast drying also usually causes checking of the top face of the board.

"Bow" in timber can be the result of overhanging ends in a stack, or from the use of strips of uneven thickness; "spring" may be due to the presence of knots or other areas of sloping grain occurring along one edge of a board. Figure 2 shows the four forms of warping.

Warping and checking of timber can be minimized by using such drying techniques as stacking timber perfectly flat, protecting it from the sun and if necessary placing weights on the stacks. (*See* section entitled **How is Timber Seasoned?**).

Properly seasoned timber, if protected from the weather, will not crack, warp or shrink. This stabilizing of timber is undoubtedly the principal advantage in seasoning timber.

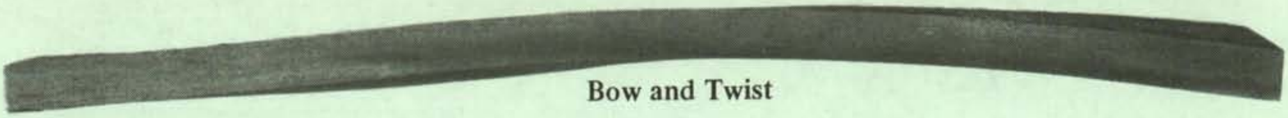
Seasoning also improves the following qualities of timber:

Strength

The drying of timber increases its strength, especially compressive, tensile, and bending strength and stiffness. This means that buildings constructed using the green strength ratings of timber actually become stronger in service as the timber dries.

Cup

Spring



Bow and Twist

Figure 2

Forms of warping in timber. (SC2405.)