Home and dry

Correct drying, handling and storage of wood adds to its value

By Nellie Oduor

Water, sometimes referred to as "sap", makes up over half the total weight of wood in a living tree. The water or moisture content (MC) of wood is expressed, in percent, as the weight of water present in the wood, divided by the weight of dry wood-substance. For instance, a 30kg plank of wood, which contains 10kg of water and 20kg of dry wood-substance, would have an MC of 50 per cent. Moisture content may be greater than 100 per cent because the weight of water in the wood can be higher than the weight of dry wood-substance.

As green wood dries, most of the water is removed. The moisture remaining in the wood tends to come to equilibrium with the relative humidity of the surrounding air (equilibrium moisture content, EMC). The process of losing moisture varies depending on air temperature and humidity. For instance, in low temperature but high humidity areas, like Limuru and Timboroa) the drying process will be slow. In areas with high temperatures and low humidity (e.g. Voi), the drying process is quicker. Timber drying, also known as timber seasoning, is done by exposing timber to circulating air and controlled heat over a given period to avoid *degradation* (value loss).

Why dry timber?

Timber is dried for the following reasons:

- **To increase its stability:** Wood in service is always undergoing slight changes in moisture content, so it is important to dry timber to a moisture content it will assume in use, to reduce shrinking or swelling.
- **To reduce inception of decay or stain fungi on timber:** Drying timber to less than 20 per cent prevents the onset of decay and stain fungi.
- **To reduce weight:** Drying reduces the weight of wood by 35 per cent or more, thus reducing handling and transportation costs.
- **To increase strength:** As wood dries, its stiffness, hardness and resistance to bending increase. Most species increase their strength characteristics by 50 per cent or more when dried, to 15 per cent moisture content. Drying also increases the electrical and thermal insulating properties of wood.
- **To prepare the timber for further treatment and use such as:**
  - **Gluing:** This is only effective when timber is dry.
  - **Preservation:** Some preservatives require timber to be dry for proper penetration of the preservative.
  - **Paints and finishes:** If the moisture content of the wood exceeds 20 per cent, there is an increased risk of blistering and peeling of paint.
  - **Machining:** Properly dried timber can be cut to precise dimensions and machined more easily and efficiently.
  - **Fitting and fastening:** Parts can be fitted and fastened with nails, screws and bolts more securely if the wood is dry.

Main factors that affect drying

A number of factors affect the drying process. These include:

- Wood species. Generally, hardwoods dry slower than softwoods.
- Initial moisture content. The higher the initial moisture content, the slower the drying rate.
- Timber thickness. The thicker the timber, the slower the drying rate.
- Economics.
- End use of the timber. Timber to be used for furniture needs to be dried to less than 10 per cent moisture content while that for construction needs to be dried to between 15 - 20 per cent.

Drying timber

To dry timber successfully, temperature, relative humidity and air circulation conditions must be controlled. Uncontrolled drying leads to defects that can adversely affect the serviceability and economics of the product. The usual strategy is to dry as fast as a particular species, thickness, and end-product requirements allow, without damaging the wood. Slower drying can be uneconomical and can introduce the risk of stain.

Drying methods

Generally, timber is dried by air (natural drying) or by artificial drying. The latter can be kiln drying, solar drying or drying using microwave kilns.

i) Air drying

This is the drying of timber by exposing it to the air. The technique consists mainly of making a stack of sawn timber (with the layers of boards separated by stickers) on raised foundations, in a clean, cool, dry and shady place. It is very important that the stickers are of uniform thickness and dryness. Stickers are usually 18.75 mm (3/4 inch) thick. Each sticker should be long enough to run across the stack without a joint. This ensures that each layer of timber is uniformly placed and adequately supported to hold the next layer. Always arrange timber of the same thickness in one stack to ensure uniformity in drying (See photo 1)

Photo 1: Well-stacked timber.

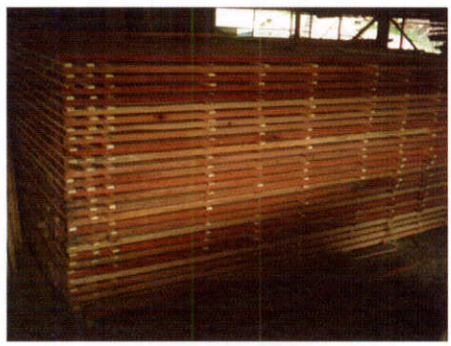


Photo 2: Poorly stacked timber.

Drying time mainly depends on climatic conditions and the air movement. For successful air-drying, a continuous and uniform flow of air throughout the pile of timber is needed. A path of at least 1 metre should be left between timber stacks (photo 3) to allow movement during observation and easy removal of timber from the stacks.

Photo 3: Inspection paths between timber stacks.

The rate of moisture loss can be controlled by coating the planks with any substance that is relatively impermeable to moisture; ordinary mineral oil is usually quite effective. Coating the ends of logs with oil or thick paint improves their quality upon drying.

Advantages of air-drying

- Air-drying saves energy costs and reduces required dry kiln capacity.
- It is cost effective. However, there are still costs associated with storing the wood and with the slower process of getting the wood to the market.
- Air-drying often produces a higher quality, more easily workable wood than kiln drying.

Disadvantages of air-drying

- Depending on the climate, it takes several months to a number of years to air-dry the wood. The drying rate is very slow during the cold months. At other times, hot, dry winds may increase degrade and volume losses from severe surface checking and end splitting. (End coating may alleviate end checking and splitting).
- Warm, humid periods with little air movement may encourage the growth of fungal stains.
- Another limitation of air-drying is the high cost of carrying a large inventory of high value timber for extended periods.

ii) Accelerated air drying and pre-dryers

Accelerated air-drying is also known as forced air-drying. This involves the use of fans to force air through timber stacked in a shed. This protects the timber from the elements and improves air circulation compared with air drying, thus improving the timber quality. Heat is sometimes added to reduce the relative humidity and slightly increase the shed temperature to aid drying.

Pre-dryers take this acceleration and control a step further by regulating both temperature and relative humidity and providing forced air circulation in a completely enclosed compartment. The typical conditions in a pre-dryer are temperatures of 27° C to 38° C, and 65 to 85 per cent relative humidity.

iii) Kiln drying

In kiln drying, higher temperatures and faster air circulation are used to increase the drying rate significantly. Specific kiln schedules have been developed to control temperature and relative humidity in accordance with the moisture content and stress situation within the wood, thus minimising shrinkage-caused defects.

A kiln schedule is a series of temperatures and relative humidities that are applied at various stages of drying. In most schedules, the temperature is gradually increased and the relative humidity decreased, thus lowering the EMC. Drying schedules vary by species, thickness, grade, moisture content and end use of timber.

The two general types of kiln schedules are moisture content schedules and time-based schedules. A typical hardwood schedule might begin at 49° C and 80 per cent relative humidity when the timber is green. By the time the timber has reached 15 per cent moisture content, the temperature could be as high as 82° C. Kiln drying reduces drying time to about four to seven days depending on timber species and timber size. The main disadvantage is the high cost of running, especially if it uses electricity.

Photo 4: Stacking a kiln timber dryer at KEFRI Karura.

iv) Solar drying

Solar kilns can operate by direct solar collection (greenhouse type) or by indirect solar collection where the collector is isolated in some way from the drying compartment. They can operate with solar energy alone or with supplemental energy

The advantage of solar kilns is the free and often abundant energy available, but the disadvantage is that there is a cost to collecting free energy. This free energy is also low-intensity, which often limits the operating temperature of a solar kiln to about 54° C unless expensive, special solar collectors are used. Another advantage of solar kilns is that they can be relatively small, simple and inexpensive, well suited to small-scale operations.

Photo 5: A solar dryer at Malindi Woodcarvers Cooperative Society.

v) Microwave drying

A new microwave technology for drying wood could revolutionise the timber industry and lead to cheaper wood in the future. This technology has been developed at the Cooperative Research Centre (CRC) for Wood Innovations, in Australia. It combines microwave technology with more traditional drying techniques, such as solar or kiln drying, to speed up timber drying.

The microwave treatment also makes the wood more permeable. This allows timber to be impregnated with resins or preservative to improve its strength, stability and durability.

What happens to timber that has not been dried?

When timber has not been dried, it will continue to lose moisture from the outside inward to come to equilibrium with its environment. It will also begin shrinking, or trying to shrink, from the outside inward. Changes in moisture content result in strain and strain-induced stresses, leading to *warp* and *fracture*. Specific types of warp are *cup, bow, twist* and *crook*. Figure 1 illustrates various types of warp that develop in boards during drying.

Specific types of fracture are *checking* and *splitting*. There is also the problem of discoloration.

(i) Warp in timber is any deviation of the face or edge of a board from flatness or any edge that is not at right angles to the adjacent face or edge. Warp can be traced to two causes:

- Differences between radial, tangential, and longitudinal shrinkage in the piece as it dries or
- Growth stresses. Warp is aggravated by irregular or distorted grain.

Surface checks (photo 6) occur early in drying when the shell of a board is stressed in tension, enough to fracture the wood. These checks occur most often on the face of flat sawn boards. End checks appear on the ends of boards and logs. End checks (photo 7) occur because the rapid longitudinal movement of moisture causes the end to dry very quickly and develop high stresses, therefore fracturing.

Discolouration

There are two general types of discolouration - chemical and fungal.

Chemical discolouration is the result of oxidative and enzymatic reactions with chemical compounds in wood. Fungal stains, often referred to as blue or sap stain, are caused by fungi that grow in the sapwood. Blue stain can develop if initial drying is too slow.

Situation in Kenya

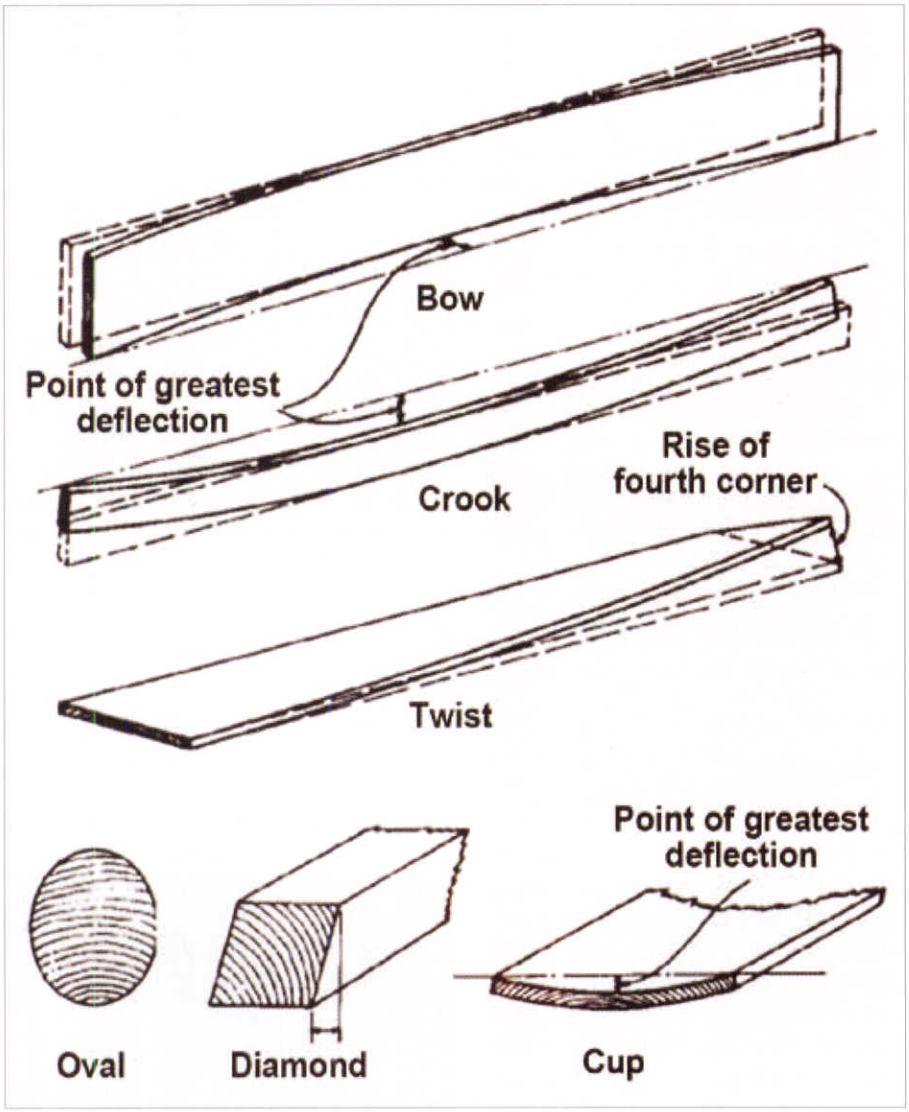
In Kenya, electric and steam heated kilns as well as air-drying are the most common methods used to dry timber. Heated kilns are expensive to put up and to run. They also require technical expertise to operate. They are therefore found in very few firms, especially where large volumes of seasoned timber are required in a short time. Air-drying is the most applicable method for small-scale timber users, sawmills and the construction industry where timber may be arranged in a yard to dry as it awaits use.

The Akamba Woodcarvers Cooperative Society in Mombasa and the Malindi Woodcarvers Cooperative Society in Malindi have a solar dryer each to dry their woodcarvings.

In Kenya, not many timber yard owners and saw millers dry their timber. One problem could be that air seasoning takes a long time and kiln drying is expensive. The other problem is that people get away with using green timber for construction, especially in putting up trussed rafters. However, this creates a problem (especially when using heavy roofing material) because over time, the roofs leak. The timber dries while in use and thus will warp and cause roofing problems. It is also very common to see doors that do not close properly because of warping.

Correct drying, handling, and storage of wood will minimise moisture content changes when the wood is in service. If moisture content is controlled within reasonable limits, major problems from dimensional changes can usually be avoided.

Figure 1: Various types of warp that develop in boards during drying.



Source: Wood handbook - Wood as an engineering material. General Technical Report FPL-GTR-190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 508 p. 2010

Photo 6: Surface checks

Photo 7: End Checks

All photos: KEFRI

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