Wood Shrinkage Explained

Collected From: http://www.woodbin.com/ref/wood/shrinkage.htm

Moisture Content of Wood

Moisture exists in wood either as "bound" water that is held chemically within the cell walls or as "free" water that is stored in the cell cavities. As freshly cut or "green" wood dries, the free water evaporates first. The **fiber saturation point** is reached when all the free water is gone, leaving only the bound water within the cell walls. The fiber saturation point averages about 28 percent moisture content. When the moisture content drops below the fiber saturation point, the wood will begin to shrink and undergo changes in its physical and mechanical properties (notably becoming stronger).

The moisture content of wood fluctuates in response to changes in the relative humidity of its environment. As the relative humidity increases, the amount of bound water in wood increases and the wood expands in size; if the relative humidity drops, the amount of bound water in the wood decreases and the wood shrinks. (these dimensional changes are basically caused by swelling or shrinking of the individual wood cells). The **equilibrium moisture content** (EMC) is reached when wood is no longer gaining or losing moisture - it has reached an equilibrium with its environment. Temperature also plays a role here: for a given relative humidity, the equilibrium moisture content of a piece of wood will decrease as the temperature increases.

Wood moisture content calculator

Wood that has been stored outside and then brought into the shop should be given time to adjust to the shop environment before being cut or otherwise machined. Failure to allow the wood to reach an equilibrium moisture content in the shop will invite warpage and other shrinkage related problems.

Dimensional Changes

As stated earlier, wood is dimensionally stable above the fiber saturation point but below that point, wood shrinks or swells due to loss or gain of bound water from the cell walls. This movement is greatest in the direction of the annual growth rings (tangential), about one-half as much across the rings (radially), and much less along the grain (longitudinally). The total amount of shrinkage that occurs in one of these three directions from the green to ovendry condition is typically expressed as a percentage of the green dimension. This shrinkage varies considerably from species to species, but as a rough **rule-of-thumb**, wood undergoes about 8% tangential shrinkage, 4% radial shrinkage, and 0.1% longitudinal shrinkage from the green to ovendry condition. Heavier (denser) woods generally shrink more than lighter woods.

The practical implication of all this to woodworkers is to make provisions for wood movement, especially across the widths of boards. Most boards are flat-sawn which results in the board faces running tangentially to the growth rings of the tree. Quarter sawn boards are much more dimensionally stable across their width because the growth rings are oriented at right angles to the board faces. They will experience greater moisture-related movement in thickness than flat-sawn boards, but this movement is often negligible because boards are generally much wider than they are thick.

Calculating Dimensional Changes in Wood

The following formula can be used to estimate the dimensional changes that a piece of wood will undergo due to changes in its moisture content. It is applicable in situations where the moisture content is at or below the fiber saturation point.

$$Dc = \frac{Di\ (MCi - MCf)}{FSP(100)/S - FSP + MCi}$$

where:

Dc = dimensional change
Di = initial dimension
MCi = initial moisture content (percent)
MCf = final moisture content (percent)
FSP = fiber saturation point (average = 28%)
S = shrinkage percentage from green to ovendry
(radial, tangential, longitudinal)

Example: Assume you have a 30" wide table top made from flat-sawn sugar maple boards with a moisture content of 14 percent. If this table top is moved to a drier location where it can be expected to reach an equilibrium moisture content of 6 percent, how much will it shrink in width? Laboratory tests have determined that sugar maple has an average tangential shrinkage of 9.9 percent. Using this figure and assuming a fiber saturation point of 28 percent, the change in width is computed by:

$$Dc = \frac{(30)(14 - 6)}{28(100)/9.9 - 28 + 14} = 0.89$$

Thus, the table top can be expected to shrink by almost an inch in width.