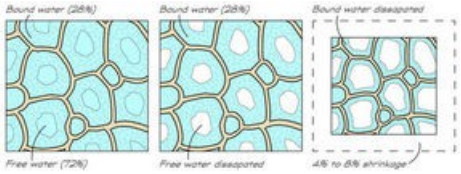
Wood moves. Because of its unique structure, it's constantly expanding and contracting. And you must cope with this movement in every project you build.

MOISTURE CONTENT AND MOVEMENT

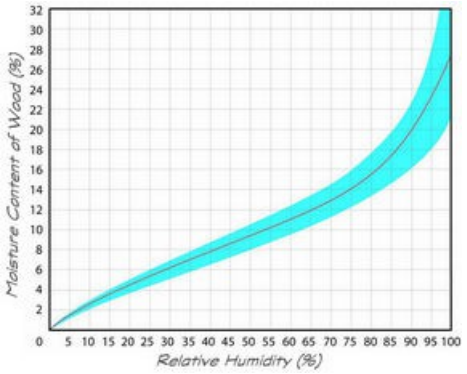
Wood moves as its moisture content changes. In a tree that's just been felled, the wood is "***green***" — sap fills the cell cavities. This ***free water*** (as the sap is sometimes called) accounts for 72 percent of the total moisture content, although this percentage may vary from species to species. The remaining 28 percent saturates the wood **fibers** in the cell walls. This ***bound water*** in the fibers causes them to swell, just as a sponge swells when you wet it.



*In green wood, free water fills the cell cavities and bound water saturates the fibers in the cell walls. As it dries, the free water evaporates first, then the bound water. The wood doesn't move until it begins to lose bound water.**

As the green wood dries, the free water evaporates first, then the bound water. The wood is dimensionally stable (it doesn't shrink or swell noticeably) as it loses free water, but once it begins to lose bound water, it contracts.

Wood dries to an average moisture content of between 4 and 11 percent, depending on the area of the country, but it never really comes to rest! The amount of bound water in the wood continually changes with the amount of moisture in the surrounding atmosphere. On the average, wood gains or loses about 1 percent moisture content for every 5 percent change in the ***relative humidity***.



*The moisture content of the wood varies with the relative humidity of the surrounding air, as this chart shows. Once the wood has been dried, the moisture content never again rises above 28 percent (its fiber saturation point) from the effects of humidity alone. For this to happen, the wood must be immersed in water.**

Humidity -- Wood doesn't always move with changes in humidity, just the ***relative humidity***. The relative humidity is the ratio of the actual moisture in the air (absolute humidity) to the maximum amount of moisture the air will hold at its present temperature. The warmer the air, the more moisture it will hold. Because of this, it's possible for the

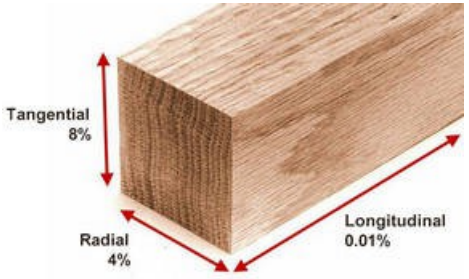
absolute humidity to change while the relative humidity remains the same. If both the absolute humidity and the air temperature rise at the same time, the relative humidity will remain constant — and the wood won't move.

The wood fibers swell as they absorb moisture and shrink as they release it, causing the wood to expand and contract. In the Northern Hemisphere, relative humidity increases in the summer and decreases in the winter. And due to the effects of heating and air conditioning, the relative humidity is generally different indoors than out. Additionally, the relative humidity may vary from one building to another if the indoor temperatures differ. Consequently, wood tends to move with the seasons or whenever you change its location.

DIRECTION OF MOVEMENT

Although it's constantly expanding and contracting, wood does not move equally in all directions. The grain structure causes it to move differently in three different directions.

- Wood is fairly stable along its ***longitudinal*** direction, parallel to the grain. Green lumber shrinks only 0.01 percent of its length as it dries. An 8-foot-long board will move only 3/32 inch.
- Wood moves much more across the grain, ***tangent*** to the growth rings. Green lumber shrinks as much as 8 percent in this direction.
- But it shrinks only half as much (4 percent) in the ***radial*** direction, extending out from the pith along the radius of the growth rings. For this reason, **quartersawn** lumber is more stable than **plain-sawn lumber**. Quartersawn lumber is cut radially and moves only half as much across its width as plain-sawn lumber, which is cut tangentially



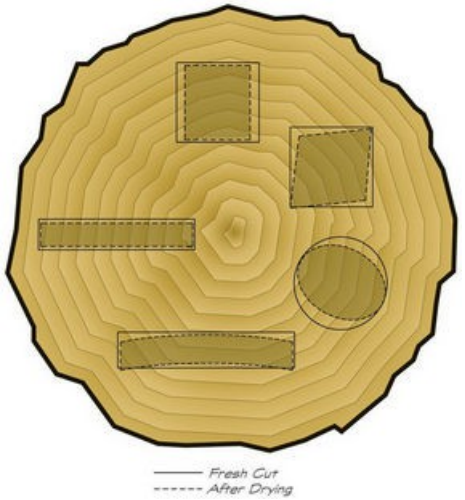
Wood is fairly stable along its length, moving only 0.01 percent as it loses its bound water. However, (on the average) it moves 8 percent tangentially and 4 percent radially.

CHANGING SHAPE

The difference in tangential and radial movement has other important consequences. Depending on how it's cut from the tree, a board may change shape as it dries:

- If the annual rings run side to side in square stock, the stock will shrink to a rectangle.
- If the rings run diagonally from corner to corner, the stock will become diamond-shaped.
- Round stock becomes oval as the tangential diameter shrinks more than the radial diameter.
- Plain-sawn lumber tends to cup in the opposite direction of the growth rings because the outside face (the face farthest from the pith) shrinks a little faster than the inside face.
- In quartersawn lumber, both faces shrink equally and the board remains flat.

And there are other forces that may cause a board to move or change shape. Stress sometimes develops in the tree as it grows or in the lumber when it's improperly dried. Internally stressed wood (called **reaction wood**) moves when you cut it. Cutting relieves some of the stress, and the wood reacts by changing shape. This is quite different from normal wood movement, however. Once the stress dissipates, it no longer affects the wood. But there's nothing you can do to stop radial and tangential movement. As long as there's weather, the boards will continue to shrink and swell.

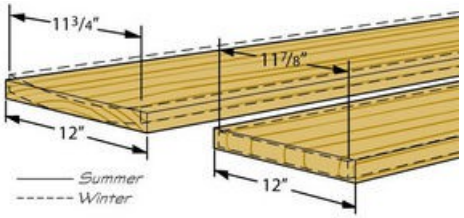


*Because of the difference in tangential and radial movement, boards change shape as they expand and contract. The way in which they change depends on how they are cut from the tree.**

ESTIMATING WOOD MOVEMENT

It's also useful to know how much a board is likely to move. You must anticipate the movement when fitting drawers and doors, inserting panels in frames, and dozens of other operations.

The rule of thumb is that if the board shows mostly flat grain on its face, allow for 1⁄4 inch total wood movement for every 12 inches



across the grain. If it shows mostly quarter grain, allow for 1⁄8 inch movement. This will accommodate an annual change of 8 percent moisture content — much more than is common in most areas.

Also consider the time of year. Wood shrinks to its smallest dimension in the winter and swells to its maximum in the summer. The wood in winter projects will expand; the wood in summer projects will contract. In the spring and fall, remember that the wood will expand half your total movement allowance and contract the other half.

*Quartersawn lumber is more stable than plain-sawn, expanding only half as much across its width. Additionally, quartersawn boards remain relatively flat, while plain-sawn boards tend to cup when they expand and contract.**