GRAIN ANGLE AND DIMENSIONAL STABILITY

Wood is an anisotropic material, meaning it shrinks and swells differently in each direction. Wood shrinks and swells the most circumferentially around the growth rings (tangentially), about half as much across the rings (radially), and only in miniscule amounts along the grain (longitudinally).

Shrinkage and Swelling

Tangential
Tangential movement of wood is a measurement of the amount the wood shrinks or swells across the circumference of the growth rings. Average values for tangential shrinkage from fiber saturation point to oven-dry are between 5-15% for most species of wood.

Radial
Radial movement of wood is a measurement of the amount the wood shrinks or swells perpendicular to the growth rings. Average values for radial shrinkage from fiber saturation point to oven-dry are between 2-8% for most species of wood.

Longitudinal
Longitudinal movement of wood is a measurement of the amount the wood shrinks or swells along the grain/wood fibers. Average values for longitudinal shrinkage from fiber saturation to oven-dry are between .1-.2% for most species of wood. Wood from near the center of the tree (juvenile wood/pith) of some species can shrink up to 2% or more from fiber saturation point to oven-dry.

Grain Angle

The strain characteristics of wood are affected by how the wood was cut from the tree, or the grain angle, which describes the orientation of the growth rings with respect to the wide face of the board. Traditional sawn material can be cut in any of the ways described on the following page:

Plainsawn
Wood that is cut parallel to the growth rings so that the growth rings are cut from 0° to 45° to the wide face of the board (a tangential cut) is called plainsawn in hardwoods, and flatsawn in softwoods. Plain sawn flooring is more dimensionally stable in thickness (radially) and less stable in width (tangentially).

Quartersawn
Wood that is cut perpendicular to the growth rings so that the growth rings are cut from 45° to 90° to the wide face of the board (a radial cut) is called quartersawn in hardwoods, and vertical-grain in softwoods. Quartersawn lumber is more dimensionally stable in width (radially) and less stable in thickness (tangentially).

Riftsawn
Wood that is cut neither parallel nor perpendicular to the growth rings so that the growth rings make angles of 30° to 60° to the face of the board is known as riftsawn in hardwoods or bastard-sawn in softwoods.

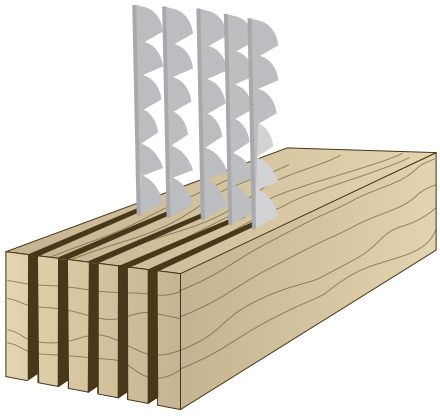
Livesawn
Wood that is cut from the outside diameter through the heartwood incorporating the full range of the above characteristics on the face of the board is known as live-sawn material. This cut of wood is typically wider and incorporates all of the above dimensional stability and aesthetic characteristics.

End-Grain
Wood that is cut so that the face of the board surface exposes the ends of the growth rings is the transverse cut, more often known as end-grain. End-grain flooring will shrink and swell according to the tangential value in the direction across the circumference of the growth rings and according to the radial value in the direction perpendicular to the growth rings, with essentially no movement in thickness.

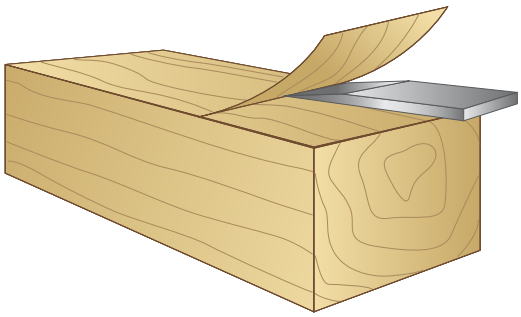
Engineered Wear Layers

Engineered wood flooring is intentionally designed to be more dimensionally stable by adhering the top veneer (or lamina) to a platform that may be made up of a veneer, composite or lumber core material. The construction of these products makes them inherently more stable than their solid counterpart.

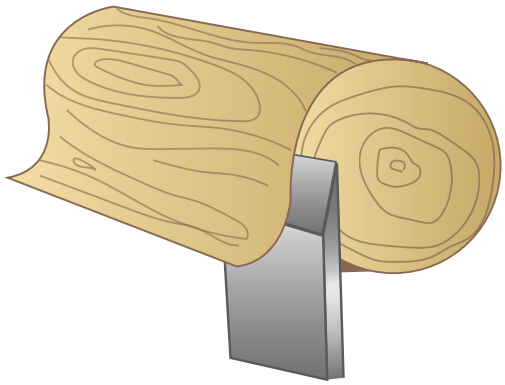
The top veneer (or lamina) of engineered flooring may be cut by 3 different methods, which are referred to as sawn, sliced and rotary peeled. These cuts affect the construction and performance requirements for each product.



Sawn Veneers
With sawn veneers, the wood is sawn in the same fashion as normal solid wood flooring, and are available in all of the cuts previously mentioned. The only difference is the thickness of the cut.



Sliced Veneers
With sliced veneers, the cant is drawn across an angled blade. The process is repeated until the whole cant has been turned into a veneer. The appearance of sliced veneer is similar to sawn veneer and will have the same natural, physical, and strain characteristics. However, slicing has thickness limits and the process can stress the wood fibers.



Rotary-Peeled Veneers
With rotary-peeled veneers, full logs are positioned on a large lathe and spun against a sharp blade. The log continues to spin until the entire log has been turned into a veneer. This technique produces the least amount of waste. Rotary-peeled veneers have a distinct, purely tangential grain pattern. The grain pattern will repeat on wide sheets.

Dimensional Stability

Dimensional stability is the degree to which a piece of solid wood maintains its original (manufactured) dimensions when subjected to changes in moisture content. (For a species comparison of dimensional stability, see NWFA Technical Publication No. A200: Wood Species Used in Wood Flooring.)

How the dimensional stability of a piece of solid wood flooring affects performance depends on how the board was cut from the log – the grain angle. As a general rule, plainsawn flooring will tend to shrink and swell more in width than quartersawn flooring, and solid flooring will not shrink or swell measurably in length.

Dimensional Change Coefficient

Different grain angles result in different properties of movement of solid wood in response to changes in moisture content. The Forest Products Laboratory of the U.S. Department of Agriculture developed the values in the accompanying chart. These values reflect the dimensional change coefficient (DCC) for the various species, measured as tangential shrinkage or swelling within normal moisture content limits of 6-14%.

The DCC can be used as a tool to determine approximately how much shrinkage or swelling to expect in solid wood with change in moisture content. A simple calculation can provide an idea of what to expect when the environmental conditions change. Simply multiply the change in moisture content by the dimensional change coefficient value for the species of flooring. Then multiply the product by the width of the flooring material. The result will indicate an approximate shrink/swell per board value based on moisture gain/loss. Keep in mind, no two trees from the same species are identical, no two boards from the same tree are identical, and properties can vary even within one individual plank of wood.

In actual practice, shrinkage and swelling may be diminished by the boards' proximity to each other, installation methods, fastening systems and moisture interactions from the substrate. These can all influence how an installed floorboard performs when it changes MC.

DIMENSIONAL CHANGE COEFFICIENT

(for common flooring species)

HARDWOODS		SOFTWOODS		IMPORTED WOODS	
SPECIES	C_T	SPECIES	C_T	SPECIES	C_T
Mesquite	0.00129	Cedar, Eastern Red	0.00162	Merbau	0.00158
Chestnut, American	0.00234	Pine, Eastern White	0.00212	Australian Cypress	0.00162
Black Cherry	0.00248	Pine, Ponderosa	0.00216	Padauk	0.00180
Maple, Bigleaf	0.00248	Pine, Lodgepole	0.00234	Teak	0.00186
Locust, Black	0.00252	Spruce, Black	0.00237	Wenge	0.00201
Maple, Silver	0.00252	Hemlock, Eastern	0.00237	Iroko	0.00205
Alder, Red	0.00256	Heart Pine	0.00263	Cumaru*	0.00212
Ash, White	0.00274	Southern Yellow Pine	0.00265	Purpleheart	0.00212
Black Walnut	0.00274	Douglas Fir	0.00267	Spotted Gum*	0.00212
Ash, Oregon	0.00285	Hemlock, Western	0.00274	Mahogany, Santos	0.00238
Sycamore, American	0.00296			Sapele*	0.00259
Hickory, Pecan	0.00315			Brazilian Walnut/Ipe*	0.00282
Elm, American	0.00338			Jatoba	0.00300
Yellow Birch	0.00338			Brazilian Maple*	0.00312
Maple, Sugar/Hard	0.00353			Jarrah	0.00396
Sweetgum	0.00365			Sydney Blue Gum*	0.00466
White Oak	0.00365				
Red Oak	0.00369				
Hickory, True	0.00411				
American Beech	0.00431				

**The estimated DCC was derived using a green to oven-dry tangential shrinkage values from Wood Handbook and other resources, assuming a 30% FSP. It is possible, however, that FSP may be less than 30% with some of these species, affecting the values given.*