



# Dimensional Stability

of Particleboard and Medium Density Fiberboard (MDF)

## technical BULLETIN

### Dimensional Stability is a Critical Factor in Construction

Moisture is always present in wood or wood products. Driven by physical forces, moisture enters and leaves wood, changing its volume and properties.

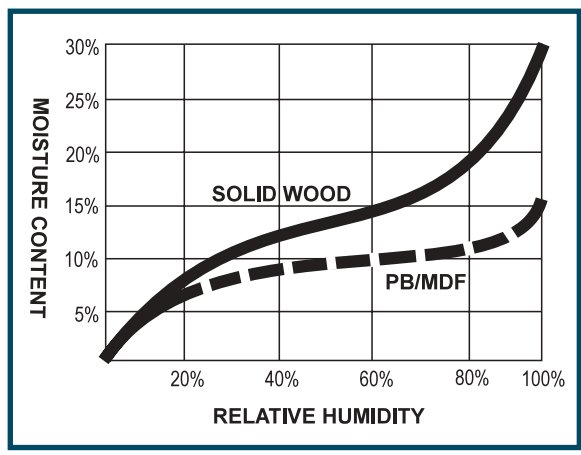
Since there is no guaranteed method for keeping moisture out of wood, appropriate design measures must be taken when building with wood products.

#### Balance of Moisture in Wood and Air

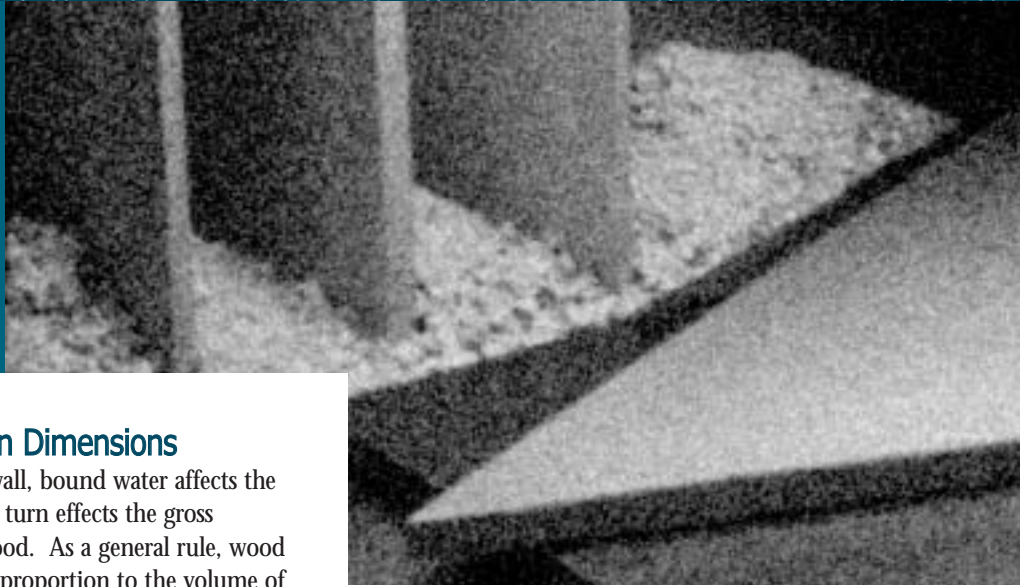
When wood is green it is saturated with water in both the cell cavities and the cell walls. The water in the cell cavities is called "free water" and the water in the cell walls is called "bound water."

Normally, free water is removed completely during the drying process. Some bound water remains and is in equilibrium with the relative humidity of the air. This equilibrium is defined by the "sorption isotherm."

All wood species more or less follow the curve shown at right. Particleboard and medium density fiberboard (MDF) follow a somewhat modified curve as indicated by the dashed line. As the relative humidity of the air changes, all wood products gain or lose water, including wood-based laminating materials like resin impregnated papers or high pressure laminates (HPL).



"Expansion or contraction in wood products is directly related to moisture content changes. The degree of movement depends on the expansion/shrinkage coefficient of the product."



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## Water's Effect on Dimensions

Residing in the cell wall, bound water affects the wood's bulk. This in turn effects the gross dimensions of the wood. As a general rule, wood swells and shrinks in proportion to the volume of water gained or lost.

For solid wood, swelling and shrinking is quite different in longitudinal vs. tangential or radial directions. These differences are significant and could result in practical problems.

## Control Dimensional Changes

One important method for reducing dimensional changes is cross lamination, a key characteristic of plywood, particleboard, and medium density fiberboard (MDF) products.

Cross lamination is accomplished in plywood by alternating the grain direction of the veneer layers in the panel or in the case of particleboard and MDF, by using randomly placed particles and fibers.

To see how cross lamination controls dimensional changes, let's use the example of a veneered lumber panel.

When there's an increase in moisture, an edge-glued lumber panel freely expands.

When restraining members, such as cross veneers, are applied to both the top and the bottom panel-prior to moisture gain-they act like steel straps nailed to the panel. They are strong enough to greatly reduce, if not totally eliminate, the expansion of the panel.

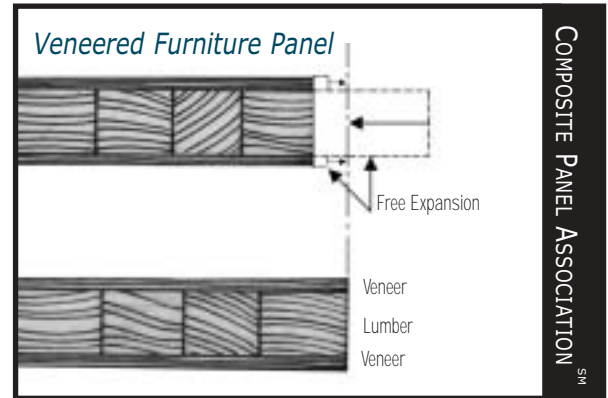
As the moisture content of the lumber panel increases, the restraining members will be stressed in tension, the lumber panel in compression.

Although significant stress occurs, the panel will stay flat as long as the forces in the restraining members are exactly equal or balanced.

An extreme imbalance occurs when the top strap is cut, resulting in a warp that's easy to see.

The problem with cross lamination is that sometimes it can be difficult to maintain balance. For exact balance, the two restraining members must be identical in:

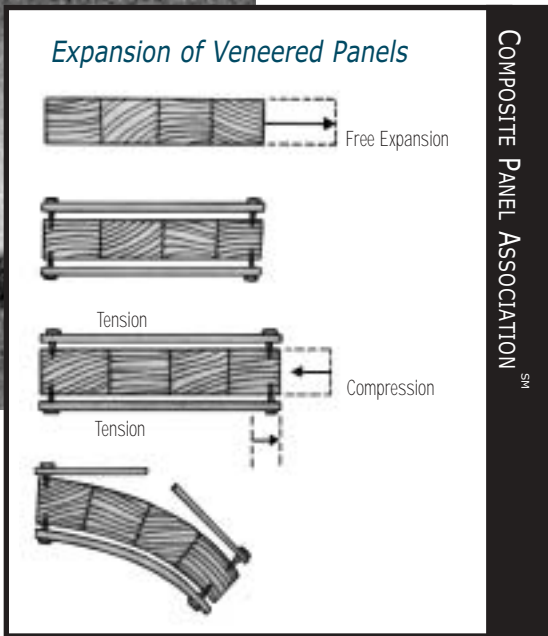
- Thickness.
- Resistance to deformation, such as stretching.
- Modulus of elasticity (MOE).
- Expansion characteristics.



Even minor imbalances in the characteristics of the restraining members can cause significant warping. The greater the potential expansion of the lumber panel, the greater the warp when a restraint is removed on one side.

## Alternating Grain Direction

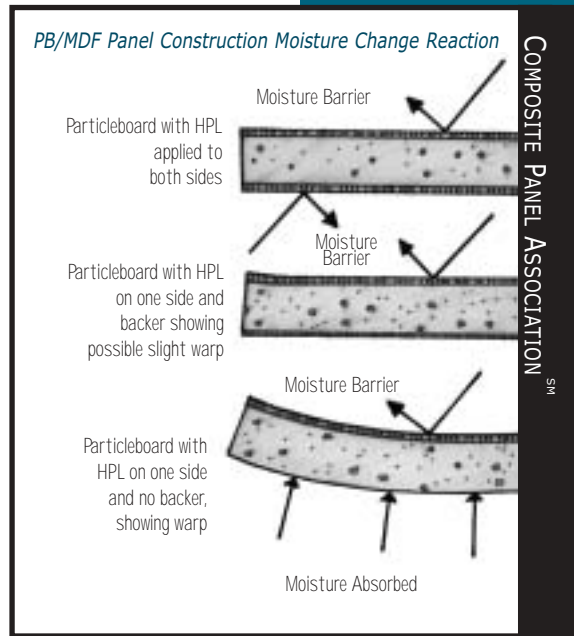
Consider a furniture panel where the veneer layers serve the same function as steel straps, except that they absorb moisture and expand.



### Using Randomly Placed Particles or Fibers

Particleboard and MDF also benefit from cross lamination because of the random orientation of their elements.

Expansion of the particles or fibers in the plane of the board is greatly reduced and is substantially the same in both directions. These properties make particleboard and MDF core materials with equal expansion characteristics in all directions.



By design, the veneer grain is arranged at 90 degrees relative to the grain of the core lumber, pairing the minimum expansion of the veneer along its grain with maximum expansion of the core across its grain.

The veneer layers effectively restrain the lumber core because of:

- Very high resistance to stretching (MOE) of the veneer along the grain.
- Relatively low resistance to compression (also MOE) of the lumber core across the grain.

Balance is vital. If the bottom veneer was only half as thick as the top veneer, it would not restrain the core as effectively and the panel would warp concavely upwards.

Relative expansion and direction of stresses are reversed when considering the other principal direction of the panel, but the mechanism is the same.

### Providing Additional Restraints

Laminating particleboard provides additional restraint, but even here allowances must be made for dimensional change as potential for warping still exists.

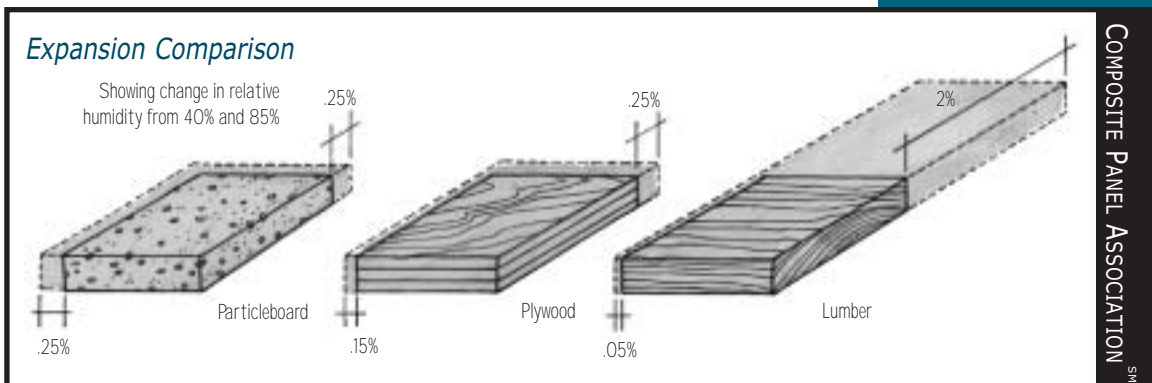
Consider particleboard or MDF overlaid with high pressure laminates (HPL), with and without backing:

- Equal thickness of HPL on both sides provides maximum stability.
- Thinner backing cannot restrain the panel with the same force as the HPL, making it vulnerable.
- If the restraint is completely one-sided, it is equivalent to the snapped steel strap in the prior example.

Both unbalanced constructions would warp concavely upwards upon moisture gain.

“Laminating particleboard provides additional restraint, but allowances must be made for dimensional change as potential for warping still exists.”

“The most certain way to minimize the degree of warp is to use balanced construction practices.”



## What is the Composite Panel Association?

### Need Backing Sheet

The lack of a backing sheet can also cause an imbalance. The top overlay could be a complete moisture barrier (like a vinyl overlay) or it could be a material which absorbs water at a much slower rate than the substrate.

As relative humidity increases, moisture is absorbed by the particleboard or MDF from the back of the panel. A moisture content gradient develops and the back of the board swells more than the top, causing the panel to warp concavely upwards.

Eventually the moisture content gradient disappears. The panel may straighten out if the overlay applies no mechanical restraint, such as vinyl. Other more rigid one-sided overlays with expansion characteristics different from that of the substrate would still result in permanent warp.

These examples all deal with expansion due to moisture absorption. Moisture may be lost through desorption and panel warp may result, but in the opposite direction.

### Balanced Construction is Key

The most certain way to minimize the degree of warp is to use balanced construction practices.

Consider the moisture-related expansion and shrinkage characteristics of wood products during design and construction to help eliminate these and other potential moisture-related concerns.

Unbalanced, one-sided countertops can resist slight warpage pressures when mechanically fastened to base cabinets. However, warp resistance depends on cabinet construction to dissipate stress. Don't forget that backer sheets also offer resistance from splashes, spills and drips.

The Composite Panel Association (CPA) is the North American trade association for the particleboard, medium density fiberboard (MDF), and other related/compatible industries. CPA is dedicated to increasing the acceptance and use of industry products and educating users about the benefits of these products.

The CPA's membership currently includes 33 of the leading U.S. and Canadian producers of industry products. Together they represent approximately 90 percent of total North American manufacturing capacity of particleboard and MDF.

The Composite Panel Association was formed in 1997 as a consolidation of the National Particleboard Association and the Canadian Particleboard Association. The CPA represents industry on technical, regulatory, quality assurance and product acceptance issues.

The CPA's Grademark Certification and quality assurance programs are the most extensive of their kind in North America, and include plant quality control audits, laboratory testing and on-site inspections. Look for the CPA Grademark on particleboard and MDF.

An affiliated organization, the Composite Wood Council (CWC) was formed in 1989 to broaden participation in industry educational and promotional programs. Membership in the CWC is highly diverse and includes more than 190 companies worldwide, including all members of the Composite Panel Association. Programs and activities of the CPA and CWC complement each other.

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