Success with
HARDWOOD FLOORING

by Howard Brickman

Moisture control and good prep work are the keys

The key to a successful hardwood flooring installation is knowledge of the materials and how to apply them. But it's not enough to simply understand the mechanics of laying a floor. It is also critical that the builder understand the prep work required in the framing and subfloor. Other than proper construction techniques, the moisture content (MC) of the subfloor components will probably have more impact on the long-term appearance of the flooring than any other single factor.

Framing Methods

In residential wood frame construction over basement or crawl space foundations there are two methods of framing: platform and balloon. With either method, it's important that you create a flat subfloor. The key points are to (1) install floor joists with the crown up, (2) discard excessively crowned lumber, and (3) properly block or bridge between joists.

With platform framing, another concern is the shrinking of the wall in thickness, particularly with the 2x6 or thicker walls sometimes used today. If the baseboard is installed before the flooring (not a detail I recommend), the shrinkage can leave a gap of $^{1}/_{8}$ inch or more between the baseboard and flooring.

Flooring Over Slabs

A concrete slab on grade is an acceptable substrate for hardwood floors as long as it is well built and sealed adequately against moisture penetration. When constructing the slab itself, place at least 6 inches of gravel or crushed stone on the ground, then install a 6-mil polyethylene vapor barrier before pouring the concrete. Make sure this vapor barrier is not destroyed when the concrete is poured.

The exterior edge of the concrete slab should be waterproofed prior to backfilling. Also, it's critical that you allow the concrete adequate time to cure and dry prior to installing the flooring. The easiest method to check for moisture in concrete is to tape polyethylene over a clean place on the slab and allow 12 to 24 hours. If signs of moisture appear under the poly, the slab is not yet dry enough.

Solid ¾-inch tongue-and-groove strip or plank flooring cannot be installed directly to concrete. You must first install a wood substrate for nailing. I prefer the "plywood-on-slab" method, in which ¾-inch plywood is nailed down—typically with power-actuated fasteners (see Figure 1).

The other approved method, more common in the South, uses short, staggered 2x4 sleepers set 12 inches on-center. These are typically set in hot mastic or asphalt flooring adhesive, but could be power-nailed instead. The

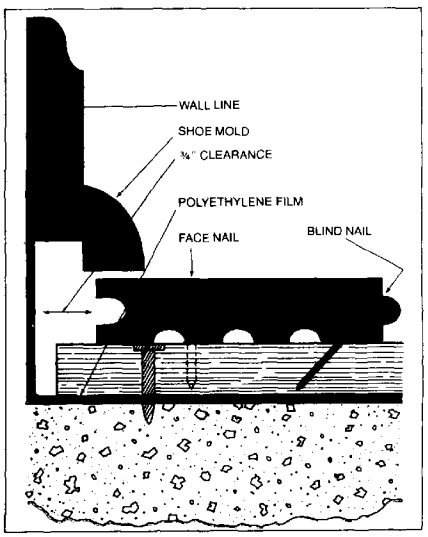


Figure 1. *The plywood-on-slab method of installing strip hardwood flooring.*

Moisture Content & Flooring Performance

Most complaints about hardwood flooring are related to changes in moisture content, Knowledge of the factors that affect moisture content is necessary to assure proper performance.

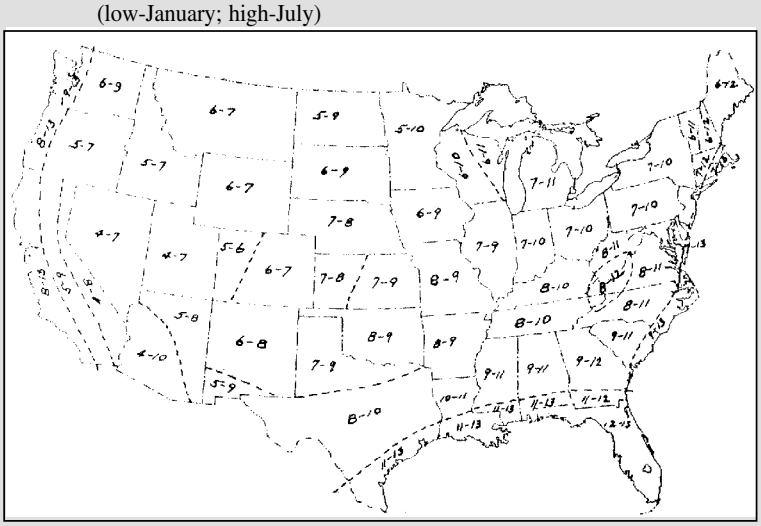
Wood is hygroscopic—that is, it will dry or pick up moisture until it is in equilibrium with the humidity and temperature of the surrounding air. The Moisture Content Map (below) shows the average moisture contents that flooring can he expected to acclimate to in winter and summer. These numbers are based on average seasonal conditions. Excessively dry or wet conditions can further change the moisture content.

The Dimension Change Chart (right) shows the average change in width of ¾x2¼-inch plain-sawn oak flooring, as the moisture content changes. Shrinkage and swelling occur between 0-percent and 25- to 30-percent moisture content, which is the fiber saturation point of wood. — *Adapted from the pamphlet* Behavior of Flooring, *by the National Oak Flooring Manufacturers' Association.*

DIMENSION CHANGE CHART (USDA)
2¼" OAK FLOORING
(The greatest possible dimensional change occurs in the tangential direction.)

A Moisture Content Difference of	May Result in an Approximate Width Change of	
1%	1/128"	
2%	1/64"	scant
3%	1/64"	full
4%	1/32"	scant
5%	1/32"	full
6%	3/64"	scant
7%	3/64"	full
8%	1/16"	scant
9%	1/16"	
10%	1/16"	full
11%	5/64"	
12%	5/64"	full
13%	3/32"	
14%	3/32"	full
15%	7/64"	
16%	7/64"	full
17%	1/8"	scant
18%	1/8"	full
19%	9/64"	scant
20%	9/64"	full
21%	5/32"	scant
22%	5/32"	full
23%	11/64"	scant
24%	11/64"	full

MOISTURE CONTENT MAP (USDA)
(low-January; high-July)



flooring is nailed directly to the sleepers with no subflooring. This method is sound, but can yield a somewhat hollow-sounding floor (Figure 2).

For the plywood method, place 6-mil poly directly over the concrete after determining that there is no excessive moisture. Lay out the plywood opposite to the direction of the finish flooring, leaving ¼-inch space between adjacent panels to eliminate squeaking. Fasten the plywood to the concrete using powder-actuated fasteners or concrete nails.

Plywood and Board Subfloors

We frequently encounter solid-board subflooring in remodeling work. With these floors, squeaks can be eliminated by renailing the boards with screw-type floor nails, which will not loosen or retract. You should replace any damaged pieces.

Plywood is the standard subflooring used today. It should be nailed every 6 inches along all joists-preferably with screw-type nails, which will not come loose as the subflooring expands and contracts with moisture changes. Loose nails can cause squeaks. Squeaks can also be caused by edges of plywood rubbing, which is why I like to see the plywood decking spaced. However, glued and nailed T&G subflooring also works well.

Some of the flooring associations allow the use of M-inch plywood subfloor. This is not thick enough, however, to provide adequate nail retention for hardwood flooring. In fact, some 5/8-inch plywood sold today even feels questionable. Since most hardwood flooring installations are in the upper end of the cost range, the savings from using thinner subflooring aren't justified. Hardwood flooring is one of the few finish materials that will last the life of the structure. It doesn't make any sense to install a hardwood floor that will have cracks and squeaks for more than a hundred years.

Particleboard and Other Composites

The particleboard used for carpet underlayment *is not suitable* for use under nail-down hardwood flooring. Other composite sheathing materials also do not have sufficient nail-holding power for nail-down hardwood floors. The latest product on the market is oriented-strand board (OSB). There has been considerable high-spirited discussion about its relative merits. The arguments go something like this:

OSB manufacturers say, "This is the best sheathing product since veneer plywood. We remove all of the defects when we make the chips. Then we mix it with an extremely water-resistant glue and compress it in monster presses to yield a very high-density, water-resistant board with no voids and performance similar to plywood of equivalent thickness. It looks good even after severe weather exposure, and is less expensive because it uses lower quality timber resources."

Builders say, "This sounds like the best thing since the hammer. If we can save $2 per sheet, we'll save $125 on subflooring for the average 2,000-square-foot house."

Hardwood flooring contractors say, "Unless this OSB is completely waterproof, it is going to absorb moisture. So what is going to keep it from expanding as this compressed material picks up moisture? Also, how is the thicker board going to return to its original thickness and density on the job site? Also isn't this new water-resistant OSB going to take longer to dry once it becomes saturated? If OSB looks good even after severe weather exposure, how can we tell when this OSB is so saturated with moisture that we should delay installation? And finally who is going to be responsible for squeaking and cracks that result from the combination of OSB and excessive moisture?"

Checking Out the Job Site

All work that would introduce excessive moisture into the structure should be completed prior to the delivery and installation of the hardwood flooring. This should he obvious, but the vagaries of construction scheduling sometimes conspire to place work out of sequence. For instance, the concrete finisher's mother may become gravely ill (common during deer season). And instead of delaying the job for Mom's ten-day recovery period and screwing up every other subcontractor on the job, the decision is made to press on with framing and pour the basement floor later. This will wreak havoc with the finish flooring.

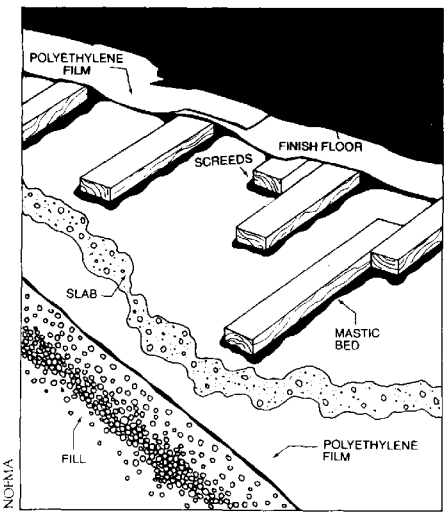


Figure 2. *Sleeper (or screed) method of installing hardwood flooring on a slab.*

Moisture-producing work such as concrete, masonry, and plastering must be completed and thoroughly dry before the floor installation. Exterior finish work such as gutters, flashing, windows, doors, and masonry should be weathertight. Also framing materials that are exposed to excessively wet conditions must be allowed to dry prior to continuing with interior finish.

The relationship of moisture and framing components is important enough to merit additional discussion. Each house is built under different weather conditions. When long, wet periods occur between the delivery of the lumber and closing in of the shell, it is critical to allow the lumber time to dry out (to about 12 to 13 percent) before installing insulation and drywall. The builder should check the lumber with a moisture meter. The new energy consciousness makes this practice doubly important since foam sheathings and house wraps on the exterior and poly vapor barriers under the drywall effectively seal the wall cavity and trap any excessive moisture within the structure.

When hardwood flooring is installed under wet conditions (subfloor beyond 10- to 12-percent MC), it expands during and after installation. It generally looks fine after sanding and finishing. Then it starts to return to its manufactured moisture content during the next heating season, and leaves what could be large cracks throughout the floor. This is particularly a problem with summer installations. If installed on a completely wet subfloor, the flooring could pick up enough moisture—12 percent or more—to cause cupping or crowning (Figure 3) or compression set (see sidebar, "Preventing Cracks.")

In the Northeast, I generally don't follow the conventional wisdom of allowing the flooring to acclimate in the building before installing it. Most often, it will only pick up moisture. Flooring is best installed at or near the average moisture content it will experience in the building—normally 7 to 8 percent in this region. Once installed, it will typically vary from 5 to 6 percent in winter to 9 to 10 percent in summer.

Installing Strip and Plank Flooring

There are four basic rules to ensure optimum performance. (1) Use 15# asphalt-saturated building paper or felt under all nail-down floors. (2) Start the flooring *straight* using a chalk line or string. (3) Use lots of nails. (4) Make use of the tongue and groove when changing direction and/or working from one room to another.

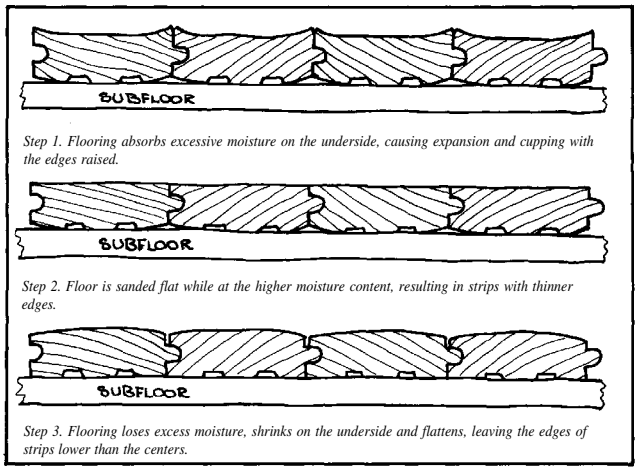
I used to believe in not using paper underlayment. However, I experimented on several installations using partial coverage of 15# asphalt building paper. There was a noticeable difference. Areas without asphalt paper were squeaky immediately after installation, and areas with asphalt paper did not squeak.

Hardwood flooring looks better and is more easily installed if it is started from a straight line. Believe it or not, some walls are not perfectly straight and should not be used to maintain alignment; The chalk line is the most effective method of maintaining alignment.

The most important single factor in producing a trouble-free installation is adequate nailing. National Oak Flooring Manufacturers Association (NOFMA) recommends maximum nailing intervals of 10 to 12 inches for strip flooring and 6 to 8 inches for plank flooring. (Wider flooring needs closer nailing to achieve the same holding power, which is a function of nails-per square-foot of flooring). Four- to six-inch spacing is even better for plank flooring to ensure a squeak-free installation. For nailing we use both the standard power nailer and the more efficient pneumatic floor nailer from Bostitch.

In addition to closer nailing, plank flooring needs additional fastening, because the wider boards (6 inches and wider) tend to twist and cup as well as shrink and expand. To control this, the ends should be screwed and plugged, and long boards may require an extra plug in the middle of the piece (see Figure 4).

Installation should be planned so that the integrity of the tongue and groove is maintained from room to room. For example, when doing a bedroom wing it is best to start in the



Step 1. Flooring absorbs excessive moisture on the underside, causing expansion and cupping with the edges raised.

Step 2. Floor is sanded flat while at the higher moisture content, resulting in strips with thinner edges.

Step 3. Flooring loses excess moisture, shrinks on the underside and flattens, leaving the edges of strips lower than the centers.

NOFMA

Figure 3. *The three steps of crowning in strip hardwood flooring.*

Preventing Floor Cracks

When flooring is delivered, usually the plastering is completed, most of the trim is up, and the windows and exterior doors are in place.

But sometimes the flooring is delivered on a damp or rainy day, exposing boards and ends to moisture. If laid in this condition, the flooring may shrink a few months later and show cracks. Very bad shinking can be expected if the flooring is laid or even stored inside the house before plaster or interior masonry work is thoroughly dry. It is better to delay completion than lay the floor while the walls are still damp.

Another condition that causes flooring to pick up moisture during construction is less obvious but more common Between the time the floor is laid and the house occupied, the temperature inside the house, both day and night, is likely to be lower and the humidity higher than when the house is occupied. So at this stage, the house should be heated to keep relative humidity low enough to avoid absorption of moisture by wood.

Compression Set

If several days of damp weather occur between the time the flooring is laid and finished (Figure A), the moisture content of the floor is likely to increase greatly. Moisture absorption is much slower after a floor has received even its first coat of finish.

Even moderate absorption of moisture from the air can cause hoards to press against one another as they swell. Heavy pressure of this sort can result in some crushing of wood fibers. Technically known as compression set (Figure B), this crushing is a common cause of floor cracks. A relatively narrow portion of each board takes the brunt of the compression. Once a board has been compressed this way, it never completely recovers.

When the flooring loses moisture after the house is occupied, each board shrinks away from its neighbors (Figure C). The width of the crack is roughly equal to the amount of crushing or "set" the board underwent while at the higher moisture content. The drying and shrinkage are most likely to occur during the winter when the house is heated and the relative humidity lower.

Further compression set can occur if the boards re-expand and press together, Such pressure may occur if the house is unoccupied or unheated for several weeks during cold or damp weather (high interior relative humidity). Foreign matter in the cracks adds to the pressure. A kitchen floor of exposed boards, in which repeated scrubbings cause the cracks to grow wider and wider as the floor grows older, shows the effects of a series of compression sets.

Keep It Dry

The only cure for floor cracks is to prevent them. See to it that the floor is put down dry, and then make sure that compression set does not occur afterwards.

(1) Assure yourself that the dealer has properly protected the stock while it was in his hands.

(2) Do not allow it to be delivered an a rainy day,

(3) Make sure that plaster and masonry are dry before the flooring is delivered.

(4) Discard all badly crooked boards or use them in inconspicuous places. Cutting them to shorter lengths helps lessen the crook in each piece.

(5) Most important, prevent moisture absorption by the flooring after it is delivered to the house.

The humidity can be lowered and the flooring kept dry by heating the house from the time the workmen leave until they return on the next workday, even during warm summer weather. Whenever possible, install the heating plant before the interior trim goes on. Otherwise, a temporary heating stove can he used. After the floor is finished, keep the temperature approximately the same as it will be when the house is occupied.

Another reason for keeping down moisture in a house nearing completion is that floors sand smoother and better when the wood and atmosphere are dry. Furthermore, low humidity protects other interior woodwork, such as doors, trim, and cabinets. *—Adapted from U.S.D.A. Leaflet No. 56.*

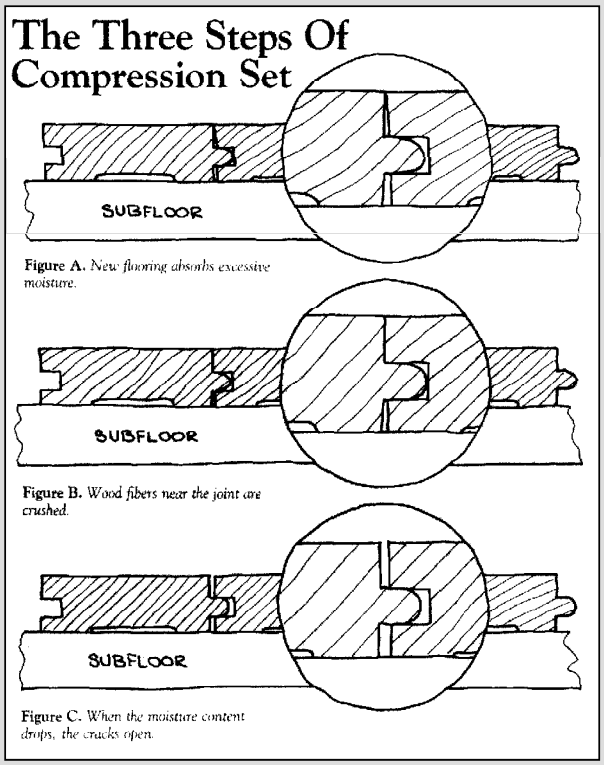


Figure A. *New flooring absorbs excessive moisture.*

Figure B. *Wood fibers near the joint are crushed.*

Figure C. *When the moisture content drops, the cracks open.*

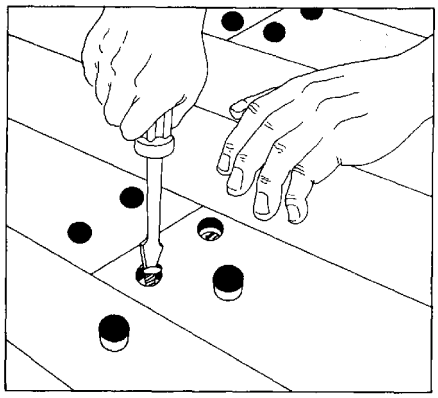


Figure 4. *For plank flooring countersink one of more #9 or #12 screws at each end of the plank, and cover with glued-in-place wood plugs. Longer planks may need additional screws at intervals along the plank.*

central hall, then take the flooring into each room using splines to reverse direction. Don't start each room individually or you'll have to tit to the flooring in the hall with narrow filler strips in the doorways. Also, if you reverse direction without a spline, you can end up with squeaks.

Baseboards and Hardwood Floors

This section is addressed to builders and finish carpenters in the Boston area. They believe that baseboards should be installed before the hardwood floors. This made sense in the old days of balloon framing, since the floor would settle relative to the baseboard. But now, every hardwood flooring manufacturer and trade association requires that expansion space be left at walls when the flooring is started and finished. It is impossible to leave any expansion space when fitting flooring tight to the base.

Kitchens

When hardwood floors are installed in kitchens, it is important to plan ahead and provide sufficient space under cabinets for under-counter appliances such as dishwashers and trash compactors. The simplest method is to install the hardwood flooring *before* installing the cabinets. An alternate system is to block the cabinets up to the same height as the finish flooring. If hardwood flooring is installed after cabinets and appliances without raising the cabinets, it will be almost impossible to replace appliances without damaging the floor or the cabinets.

For More Information

The National Wood Flooring Association (NWFA, 2714 Breckenridge Industrial Ct., St. Louis, MO 63144) represents all segments of the hardwood flooring industry from the smallest installer to the largest manufacturer. They provide a toll free information line at 800/422-4556.

The National Oak Flooring Manufacturers Association (NOFMA, 8 North Third St., Memphis, TN 38103; 901/526-5016), and the Maple Flooring Manufacturers Association (MFMA, 60 Revere Drive, Suite 500, Northbrook IL 60062; 312/480-9080) are manufacturers' groups that establish standards for production and grading, and provide technical information and a complaint-inspection service for their members' products. ■

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