Managing Moisture on the Job Site

One of the biggest headaches for a wood flooring professional is dealing with customer complaints. If you're like many contractors, many of the complaints you get have to do with moisture-related problems, like cracks between boards, cupping or crowning. You can go a long way in preventing the complaints, however, if you take the proper precautions in installation and educate the customer about what to expect.

To begin, it's important to understand the basics of how wood interacts with moisture. Wood is hygroscopic, meaning that it gains and loses moisture as the relative humidity and temperature of the air around it changes. Depending on humidity, wood will reach equilibrium moisture content (EMC). As the EMC of the wood flooring decreases, the wood shrinks; as the EMC increases, wood expands.

The effort to minimize moisture problems starts at the manufacturer, where most lumber is dried to a moisture content of 6 to 9 percent before being milled. Until it is installed, the flooring should be stored in an enclosed, well-ventilated building that is clean and dry. The flooring should never be unloaded in wet weather. At the job site, avoiding moisture problems begins with installing the proper flooring. Solid products should never be installed in rooms that are exposed to excessive moisture, including any room that is below grade — even walk-out basements. (Engineered wood floors are appropriate for below-grade installations.) If drastic humidity changes are expected, species with above-average dimensional stability can be chosen.

Before flooring reaches the job site the structure should be fully enclosed, with doors and windows in place, and interior climate controls should have been operating for at least 48 hours. Wet trades such as painting and plastering should be completed and dried.

Once the interior is at normal living conditions, wood flooring should be set indoors and spread over the subfloor, with at least four days passing before installation is started. (Manufacturers of engineered flooring products say no such acclimation time is necessary.)

Before work begins, check the moisture content of the concrete slab and/or wood subfloor. For wood subfloors, check several different areas with a moisture meter and average the results. A moisture content of 12 percent or less is considered acceptable in most regions. The level must be within 4 percentage points of the moisture content of the flooring to be installed. For solid plank flooring, the level should be within 2 percentage points.

Several methods are available to test concrete, from concrete-specific moisture meters to physical methods such as calcium chloride tests. Whatever the means of testing, the emission of moisture vapor from the floor should not exceed 3 pounds per 1.000 square feet per 24 hours. Normally concrete should be at least 60 days old to meet this requirement, although flooring can be installed before that if moisture tests indicate that the slab is ready. Always check the wood flooring manufacturers' recommendations for "acceptable moisture content."

Even if subfloors are within an acceptable range, that doesn't mean moisture won't seep from the ground into concrete and sub floors in the future. That's why it is imperative that the installer uses a moisture-vapor retarder. If construction is over a concrete slab, a barrier of heavy plastic film should have been laid between the base of gravel or crushed stone and the slab. Before flooring is installed, another barrier or

retarder should be laid over the top of the slab. This could be one of a variety of materials — low-end PVC vinyl, polyfilm and 15-pound roofing felt are all used, among others. In joist construction, a vapor retarder of 15-pound saturated felt paper should be laid between the wood subfloor and the wood flooring. If the wood subfloor is laid over a concrete slab, the felt paper can be cemented to smooth, clean-swept concrete.

Whatever the method used, installers should verify the acceptability with the flooring manufacturer. If gluing down over a moisture retarder, they should also check with the adhesive manufacturer for compatibility

Once installation has begun, it is important that nailing recommendations be followed. With wider flooring, fasteners should be used closer together. Wide planks are often also screwed down to increase stability.

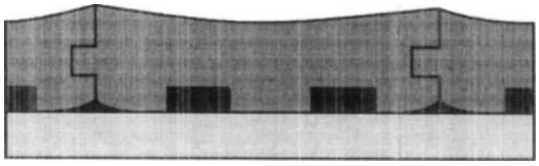
Once the installation is complete and all the necessary precautions have been taken, your best chance of avoiding future problems is customer education. All your painstaking work to prevent moisture problems will go awry if the customer starts damp-mopping the floor once a week. And you'll save yourself a headache in the fall if you let them know that small cracks may appear at that time of year. Just as with the actual installation, it pays to be prepared.

Wood Flooring Expansion and Contraction

Unlike many floor coverings, wood floors can last the lifetime of the building in which they are installed. Home owners who want them to last that long, however, should note the number one enemy of a hardwood floor: moisture. Wood floors naturally expand when moisture is present and shrink when it is not. Whether the reactions are a problem or not depends on the severity of the situation. Following are some of the common results when water and wood floors combine:

CRACKS BETWEEN BOARDS: Almost every wood floor endures some expansion and contraction as seasons and humidity levels change. When homes are heated, humidity levels plummet, boards shrink and spaces appear between the boards. In dry months, cracks can easily develop to the thickness of a dime on a typical solid 2.5-lnch oak floor, with light-colored woods making the cracks appear larger. Plank floors also will show cracks more. These spaces are to be expected and usually close up as the season changes and moisture returns to the air. To reduce the degree of change, home owners can add moisture to the air during the dry months, ideally by installing a humidifier in the furnace.

CUPPING: As with cracks between boards, both cupping and crowning are natural reactions to moisture and should not be a concern if they occur only to a minor extent. More severe cases, however, indicate a serious moisture problem.

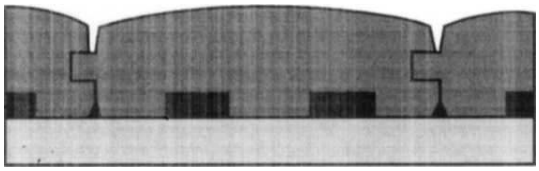


"Cupping" describes a condition in which the edges of a board are high and its center is lower. Humidity is usually the culprit, although cupping also can happen after water has been spilled onto the floor and absorbed into the wood. The moisture causes the wood to swell, crushing the boards together and deforming them at the edges. In order to repair the floor, the cause of the moisture must be identified. Most often, indoor humidity will have to be controlled.

Other causes could include situations such as a plumbing leak in the basement, which can allow moisture to migrate up into the subfloor and the wood flooring.

Once the cause of the moisture is controlled, cupping usually can be reversed. Oftentimes the floor may naturally dry out and improve over time. Fans may be necessary to speed the drying process. After the floor has dried, it may be necessary to recoat the floor with finish, or to sand and refinish the floor.

CROWNING: "Crowning" is the opposite of cupping: The middle of the board is higher than the edges of the board. This can occur when the surface of the floor encounters moisture. More often, it results when a floor has been sanded too soon after It has cupped. When this happens, the top edges of the board are sanded off, and thus are lower than the rest of the board when ft returns to normal moisture content.



BUCKLING: Buckling is one of the most extreme reactions to moisture that can occur with a hardwood floor. It happens when the floor literally pulls away from the subfloor, up to heights as high as several inches. Fortunately, buckling is an uncommon occurrence, usually happening only after a floor has been flooded. Even in such cases, it is possible that a floor can be repaired instead of being totally replaced.

Preventing Moisture Problems

Controlling humidity is the most important factor in preventing problems with moisture and your wood floor. The correct maintenance also will go a long way in avoiding problems. Among the key points:

- Clean your wood floor with a cloth lightly dampened by a recommended cleaning product, using the manufacturer's directions for use. It is best to buy a "floor care kit" recommended by your wood floor installer or retailer.
- Do not clean your wood floors with water or water-based products on a regular schedule — clean only when necessary and clean only the soiled areas
- Never damp mop a wood floor. The water deteriorates the wood and the finish
- Never let a water spill dry on the floor

Water Craft

Ten things you need to know about moisture and wood

Sources of Moisture

- Framing and subfloors in new construction: When a structure is going up, the framing and subfloor materials often get rained on, and this moisture is often trapped in the house
- Ground water: Sometimes the water table is raised above the bottom of the foundation as a result of heavy or prolonged rains or other causes
- Surface water: Rain water falling on the ground or from the roof can pass through or under the foundation walls.
- Crawl space: Symptoms of excessive moisture passing up through the floors may include a musty odor; mold on the walls near the floor; moisture condensation on insulated windows or storm windows; and moisture condensation in the walls with resulting paint peeling.
- Capillary rise of ground moisture: Moisture travels upward by capillary action and evaporates within the crawl space, or it can be drawn through both the subfloor and the concrete below it.
- Relative humidity: When humidity increases, the effect on the wood floor can be damaging. This occurs most frequently in homes in which occupants are there for a short period of time

You hear it said so often that it's become a cliché — "water and wood don't mix"— but in reality, water and wood are inextricably linked, from the time a tree begins to grow and continuing throughout the wood's years of service as flooring. Flooring professionals and customers alike would do well to understand the relationship between water and wood, and the normal way wood behaves as moisture is added or subtracted. If you want to ensure a successful and lasting installation, here are 10 things you should know about the relationship between moisture and wood flooring:

1. **Wood tends to contract as water is subtracted from its cell structure and expand as water is added**. That's true when a tree is harvested and cut into lumber, and it's still true decades after the wood has been installed as flooring. This basic premise underlies everything else you need to know about water and wood.
2. **Excessive moisture within a structure will tend to be absorbed by wood flooring, causing the wood to expand.** In the most severe cases, the flooring can actually buckle and pull away from the subfloor. Excess moisture might come from a concrete slab foundation that's not sufficiently cured, a crawl space that's not properly ventilated, or from a variety of other sources.
3. **The structure should be at "normal living conditions" before wood flooring is brought to the site for acclimation and installation.** "Normal living conditions" means that the environment within the structure is at approximately the temperature and relative humidity that will be experienced during occupancy — during the life of the floor That means the structure should be fully enclosed, with doors and windows in place, and interior climate controls should be

operating for at least 48 hours to stabilize the moisture conditions of the interior. Wood flooring also should not be delivered to the jobsite until plastering and painting are completed and dried. Moisture evaporates from damp walls into the air within the house, and some of it will be absorbed by the flooring

4. **Wood flooring that is installed too wet for a home's normal living conditions will eventually give up the excess moisture contained in the wood's cell walls and will shrink, leaving unacceptably wide cracks between boards.**
5. **Wood flooring that is installed too dry for a home's normal living conditions will eventually absorb moisture and will expand, creating cupping and — in extreme cases—buckling.**
6. **To avoid the problems created in Nos. 4 and solid wood flooring should be acclimated at the job site until it reaches a moisture content that is consistent with normal living conditions within the structure. Engineered wood flooring usually does not require full acclimation before installation.** Acclimation can take several days or even weeks, depending on how much difference there is between the moisture content of the flooring when it is delivered and the appropriate moisture content for installation. The ideal moisture content for wood flooring installation can vary from an extreme of 4 to 18 percent, depending on the Wood species, the geographic location of the end product and time of year. Most oak flooring, for example, is milled at 6 to 9 percent, but wood at 9 percent moisture content may need to acclimate several days at the job site if the equilibrium moisture content of the site is 4 percent or 14 percent. Experience and moisture readings from previous, similar job sites are your best guides to determining the proper equilibrium moisture content for a site.
7. **Solid wood flooring should not be installed below grade. However, engineered flooring may be successfully installed above, on or below grade.** Because it displays far less expansion and contraction with moisture changes, engineered flooring can be successfully installed in areas with wide humidity variations. Below grade is defined as any part of the slab having four inches or more of earth above it. Additionally, walk-out basements are considered a below-grade application, even if a portion of the basement is above ground.
8. **Wood flooring should not be installed over any subfloor or concrete slab that is not sufficiently dry.** In the case of a wood subfloor (plywood or OSB, for example), the moisture content of solid strip flooring should be within 4 percentage points of the subfloor. That means that if your target moisture content for the wood flooring is 8 percent, the wood subfloor should register no more than 12 percent moisture content. Concrete slabs can present even more of a moisture challenge. Regardless of age or grade level, concrete will emit or conduct some degree of moisture, usually in the form of a vapor. Water in concrete is necessary to continue the process of curing well past the first few critical weeks. Therefore, all slabs should be tested for moisture before the floor's installation. Checking the moisture content of a slab can start 30 days after the slab is poured. However, in most cases it will take 60 days or more before the slab is dry enough for wood flooring installation to proceed. NWFA guidelines specify that emission of moisture vapor from a concrete slab should not exceed 3 pounds per 1,000 square feet per 24 hours.

9. **Testing for moisture should be a standard part of any pre-installation process.** That includes testing the sub-floor and slab, testing the interior environment of the structure, and testing the wood flooring itself. For testing wood floors and subfloors, hand-held moisture meters are the most important tools. Some moisture meters are also capable of testing concrete, but there are several other approved tests as well. Among the most common are the calcium chloride test, the polyfilm test, the humidity meter test and the phenolphthalein test.
10. **Moisture retarders or moisture barriers will inhibit the effects of subsurface moisture on wood flooring.** Moisture retarders are required in crawl spaces, beneath a concrete slab, between wood floors and concrete slabs, and are also recommended between wood floors and subfloors. In crawl spaces, a ground cover of 6-or 8-mil polyethylene sheets (preferably black) should be placed over the entire area of the crawl space soil, lapped at least 6 inches and held in place by bricks or other weights. In cases where concrete is poured to create a floor in the crawl space, the 6- or 8-mil polyethylene cover is still required. Beneath a concrete slab, a heavy plastic, uninterrupted film should be laid between the base of gravel or crushed stone and the slab. Since placing this moisture barrier is normally beyond the control of the flooring contractor, the builder or home owner should be advised of this requirement before the slab is poured. Between the slab and the wood floor or subfloor, there should be another moisture barrier or retarder. Common choices include low-end PVC vinyl adhered to the slab with a multipurpose adhesive; 6-mil polyethylene film applied over a skim coat of asphalt mastic; 15-pound roofing felt in asphalt mastic; and rubberized elastomeric membrane. Solid strip or plank flooring requires a felt paper moisture retarder between the floor and subfloor. If a wood subfloor is laid over an existing slab, the moisture retarder can be cemented to smooth, clean-swept concrete

Take the lead

Wood flooring contractors are rarely responsible for creating adverse moisture conditions at the job site, and sometimes moisture-related problems are beyond the flooring contractor's ability to resolve them. However, flooring contractors are responsible for knowing the appropriate moisture conditions, identifying potential moisture problems whenever possible and advising customers accordingly. It's also a flooring contractor's responsibility to not install wood flooring until the moisture conditions are appropriate.

Pell-Mell Plank

Rushing a job results in a wood floor mess

The Problem

I was called to inspect the wood flooring in a home in the low country of South Carolina. The plank floors were showing signs of cupping. When I did the inspection in May, the floors had been installed for approximately four weeks.

The Procedure

Because of high ebb tides and storm surges from hurricanes, houses built in the flood plains near the ocean must be built on piers. This particular house was built 15 feet high and was located in the flood plain of the Ashley River on an island near Charleston, S.C. It was a model home in a new development. The wood flooring—solid 5-inch-wide hickory plank—was installed in the entire first floor, stairs, and the landing at the top of the stairs.

The first shipment of wood flooring had been refused and returned to the mill. Within three to four days after the replacement wood arrived in the retailer's warehouse, the general contractor demanded the wood be installed, and the retailer complied. The wood was taken to the house, and installation started the next day. I was told that no moisture readings were taken.

The Cause

When I arrived, the temperature inside the house was 87 degrees Fahrenheit and the relative humidity was nearly 60 percent. The HVAC system was not turned on.

I did many random moisture tests with a pin meter. The results averaged 10.2 percent moisture content (MC). I did several moisture tests of the double layer of plywood. The results averaged 12.5 percent. In this area of the coastal region, 12 to 13 percent MC readings are normal.

I also measured a 20-board run. Each of the planks had swollen 1.64Jm to 1.32 of an inch. The average MC for each board was almost the same as the random MC test (10.2 percent).

By this point, the analysis of the case seemed simple—the wood was not acclimated—but, there was even more. I did tests for the nailing pattern/schedule and found that the schedule was irregular. The fasteners ranged from a few inches to more than 12 inches in many locations. For plank flooring this wide, the recommended distance is 8 inches. In addition, the interior environment was not being maintained to NOFMA and NWFA standards.

The choice of wood also was a consideration. Plank flooring has a natural tendency to cup slightly due to its width and grain orientation. However, this is a hickory, which has a tangential dimensional change coefficient (or shrinkage/swell ratio) of 0.00411. That ranks it as one of the more volatile common wood flooring species in terms of shrinkage and swelling. This ratio can be used to predict how much the floor may shrink or swell with loss or gain of moisture. To calculate this, you simply multiply the width (5-inch) by the shrinkage/swell ratio for the tangential cut (for hickory, 0.00411), which in this case equals 0.02055 for each percentage of MC gained or lost. Multiplied over the entire width of the room, this becomes significant movement.

It is because of these factors that wood flooring must be properly acclimated to the site. Wood is typically dried to a MC between 6 and 9 percent. The MC of the subfloor,

remember, was 12.5 percent. The wood cupped because of too great a MC differential between the plank flooring and the subfloor.

How to Fix Floor

While many cupped wood floors can be saved after the MC stabilizes by sanding and refinishing, this one because of the incorrect nailing pattern and lack of fasteners could not be saved. It required removal of the existing floors and installation of new flooring.

In the Future

Who was at fault? The GC who demanded installation before it acclimated? The retailer for agreeing? The installer for doing it? In my opinion, there was enough blame for everyone!

Many wood flooring contractors get into similar trouble because of pressure from builders or homeowners to install the flooring before it has acclimated. They feel that if they insist on the recommended job-site conditions (building closed in with all windows and doors installed, HVAC system running for at least 48 hours, job site at "normal living conditions," all wet trades such as dry walling and painting completed), they'll lose business. When they ignore these requirements, they do generate more business—for inspectors such as me. And, in unfortunate circumstances such as this one, they usually must assume the full financial responsibility for the failed floor.

It isn't always easy, but don't take chances with your customers' floors. Acclimate the flooring, take MC readings of the subfloor and wood flooring, and document those readings. Make sure they're within the correct range before you install the flooring.

Separation Anxiety

Lack of acclimation results in a buckled floor

The Problem

I do many wood floor inspections around Florida, and summer is the time for the usual rash of cupping problems. On the latest call, a contractor said the floor he installed had cupped and even was buckling in some areas.

The Procedure

The contractor installed a prefinished wood floor over an existing wood subfloor on the second floor of a home in Miami. He checked the moisture content of the subfloor, getting a reading of 11 to 14 percent. The flooring's readings were a consistent 8 percent. Since he had never installed this product before, the contractor called the manufacturer to ascertain what the moisture content of this product should be. The technical service person he spoke with told him that the moisture content when shipped usually is at 8 percent, and that it should be fine to begin the installation. Wrong! Shortly after the floor was completed, it began to cup, and within a week, it was buckled off the subfloor in several places. To say the least, the finger-pointing blame game had begun.

The Cause

Let's start with the fact that wood is hygroscopic; that is, it will either give off moisture or absorb it depending on the environment. To explain this, think about ways hardwood, such as oak, was used over the years to construct items like buckets and boats. The wood was soaked in water until it swelled up enough to become watertight. This process "acclimated" the wood to make it a bucket or a boat. If the wood dried out, the bucket

wouldn't hold water, or the boat would sink. The same holds true for wine barrels or whiskey barrels. It almost makes one think that flooring is a waste of good hardwood. The key is, don't change the conditions.

How to Fix the Floor

Since the customer doesn't want the floor fixed by sanding it, the contractor is stuck with having to replace it

In the Future

The wood floor contractor's mantra is "acclimate the flooring to the conditions in which it is going to be used." This sounds simple, but in reality, it is like playing a game in which the rules keep changing during the game. As a professional contractor, you predict as best you can what the rules will be. Take into account your geographical area, and refer to NWFA's Water and Wood technical manual. Use a moisture meter to make sure the floor is within the suggested parameters. Talk to the end user—do they use the HVAC all year? Do they use a dehumidifier or humidifier? Do they shut the building down for long periods of time during the year?

With some flooring, to unwrap or not to unwrap - that is the question. Most floating floors must be left in the plastic-wrapped factory carton before they are installed. If the cartons are opened and the flooring exposed to the moisture in the environment, you may not be able to fit the tongues into the grooves. On the other hand, many imported solid products also are coming wrapped tight in plastic. Solid products always should be unwrapped and allowed to acclimate to the job site. Some of my recent inspections also would suggest that bamboo floors should be unwrapped and allowed to acclimate, as well.

Easy Formula for Acclimation:

1. Remove wood from plastic packaging, if applicable.
2. Use your moisture meter and hygrometer to check and monitor moisture.
3. Err on the side of the wood shrinking. Filling is a far better thing than refinishing.

Finally, if you are calling a manufacturer for information, be specific as to where the floor will be installed on the job site, as well as its geographic location. Let them know the particulars of the installation. The more information you give the better answers you will get