by David Frane

FRAMING DETAILS FOR WOOD SHRINKAGE


C. BATES

To avoid wavy floors and binding doors, use quality framing materials and details that allow for lumber shrinkage

Early in my carpentry career, I was asked to remove all the trim from the third-floor hallway of a 140-year-old house we were renovating. All the baseboards in the hallway were touching the floor, except for one piece, which was 2 inches off the floor. It didn't make sense until I had removed the baseboard in the hallway. While most of the walls consisted of plaster and lath over studs, the wall behind the base that didn't touch the floor was plaster over a brick chimney. When the house was originally built, the air-dried framing lumber dried and shrank, and all of the third floor dropped except for that one piece of baseboard fastened to the chimney.

Today, most builders frame with kiln-dried stock. But if you think that means you don't have to be concerned about wood shrinkage, think again: Kiln-dried lumber will definitely shrink. How much depends on its moisture content at the time of installation (see "Calculating Shrinkage"). And as the lumber shrinks, it tends to twist and bow, causing humps and nail pops in walls, and bumpy, squeaky, out-of-level floors.

Understanding Wood Shrinkage

Moisture affects wood the same way it affects a sponge. If you take a sopping-wet sponge and wring it out, you'll remove some of the water, though not

Calculating Shrinkage

Because wood shrinks and swells at a predictable rate, it's possible to calculate how much a building, or any part of a building, will shrink as it dries. Let's say we want to find out how much a kiln-dried Hem-Fir 2x12 at 19% MC will shrink if it's dried to 8% MC. We need something called the coefficient for dimensional change — the shrinkage coefficient — which expresses the percentage change in the size of a piece of wood for each percentage change in its MC. Although different wood species have slightly different shrinkage coefficients, an average number for flat-sawn framing lumber is .0025. You can safely use this to calculate the shrinkage for average 2-by stock.

With that in mind we can use the following formula:

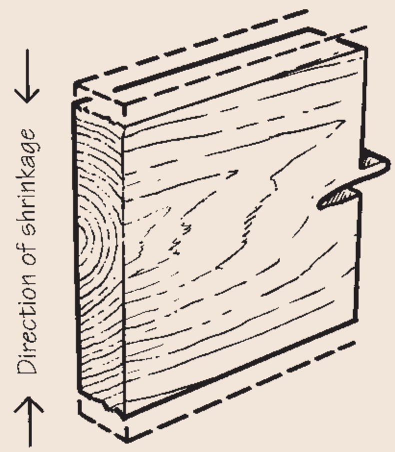
Shrinkage (or swelling) = Width of wood x change in MC x Shrinkage Coefficient

So a typical 2x12 will shrink about 5/16 inch as it moves from 19% MC to 8% MC (11.25 inches x (19-8) x .0025). A 2x6 would shrink half as much (see chart, below). The formula can also be used to calculate how much wood swells as MC increases.

Predicted Shrinkage of Dimension Lumber

Lumber Size	Actual Width	Width @ 19% MC (at Delivery)	Width @ 11% MC (Humid Climates)	Width@ 8% MC (Average Climates)	Width @ 6% MC (Arid Climates)
2x4	3 1/2"	3 1/2"	3 7/16"	3 3/8"	3 3/8"
2x6	5 1/2"	5 1/2"	5 3/8"	5 5/16"	5 5/16"
2x8	7 1/4"	7 1/4"	7 1/8"	7 1/16"	7"
2x10	9 1/4"	9 1/4"	9 1/16"	9"	8 15/16"
2x12	11 1/4"	11 1/4"	11"	10 15/16"	10 7/8"

Note: *Framing lumber shrinks primarily across its width; shrinkage along the lumber length is insignificant. Actual shrinkage varies depending on the lumber's moisture content when delivered and the area's climate.*



enough to change the sponge's size. But if you let the damp sponge dry out, it will shrink. And if you wet the dry sponge, it will swell back up until it reaches the point where it can't absorb any more water and can't get any larger.

In a piece of wood, moisture resides both in the cell cavities and in the cell walls. Green wood is like a sopping-wet sponge: As it dries, the moisture in the cavities is the first to go. But, as with the sponge, this doesn't cause the wood to shrink. The point at which there is moisture in cell walls, but not in cell cavities is called the *fiber saturation point*. Below this level, the wood (like the sponge) will shrink as it dries and swell as it absorbs moisture.

The amount of moisture in a piece of wood is referred to as its *moisture content* (MC). Moisture content is the ratio of the weight of the moisture in a piece of wood to the weight of the piece of wood if all of the moisture were removed. Because the water in a piece of green wood can easily outweigh the wood fiber, wood can have a moisture content of more than 100%. The fiber saturation point of most wood species is 25% to 30% MC; kiln-dried framing lumber is supposed to have no more than 19% MC. Since this is well below the fiber saturation point, the wood will swell and shrink with changes in moisture content.

Wood stored at a constant humidity eventually reaches a stable MC, called the *equilibrium moisture content*. For most of the U.S., the equilibrium MC of wood that's inside a building is around 8%. In arid climates like Arizona, it's closer to 6%, while in moist climates like Florida, it's closer to 11%. This means that a piece of kiln-dried lumber will lose 8% to 13% MC after installation.

Start With Dry Lumber

Kiln-dried framing lumber is stamped KD or S-DRY (surfaced dry). Lumber stamped S-GRN (surfaced green) has not been kiln dried. Its MC was higher than 19% at the time it was milled — probably a lot higher. Avoid S-GRN lumber anywhere you're concerned about shrinkage. Also be aware that anything larger than a 4x4 isn't available in KD. The outside of these timbers may be somewhat dry, but assume that the inside is pretty green. When using a large solid beam, like a 6x6 or a 6x10, keep in mind that it will shrink a lot more than a comparable built-up beam made from kiln-dried stock.

You can minimize the effects of moisture swings by ensuring that all your framing lumber has the same MC. This means storing it up off the ground and protecting it from sun and rain with a tarp. It's just as bad to let the joists on top of the lift dry out in the sun as it is to let the bottom ones soak in a puddle. The idea is to make sure that all of the members in a given

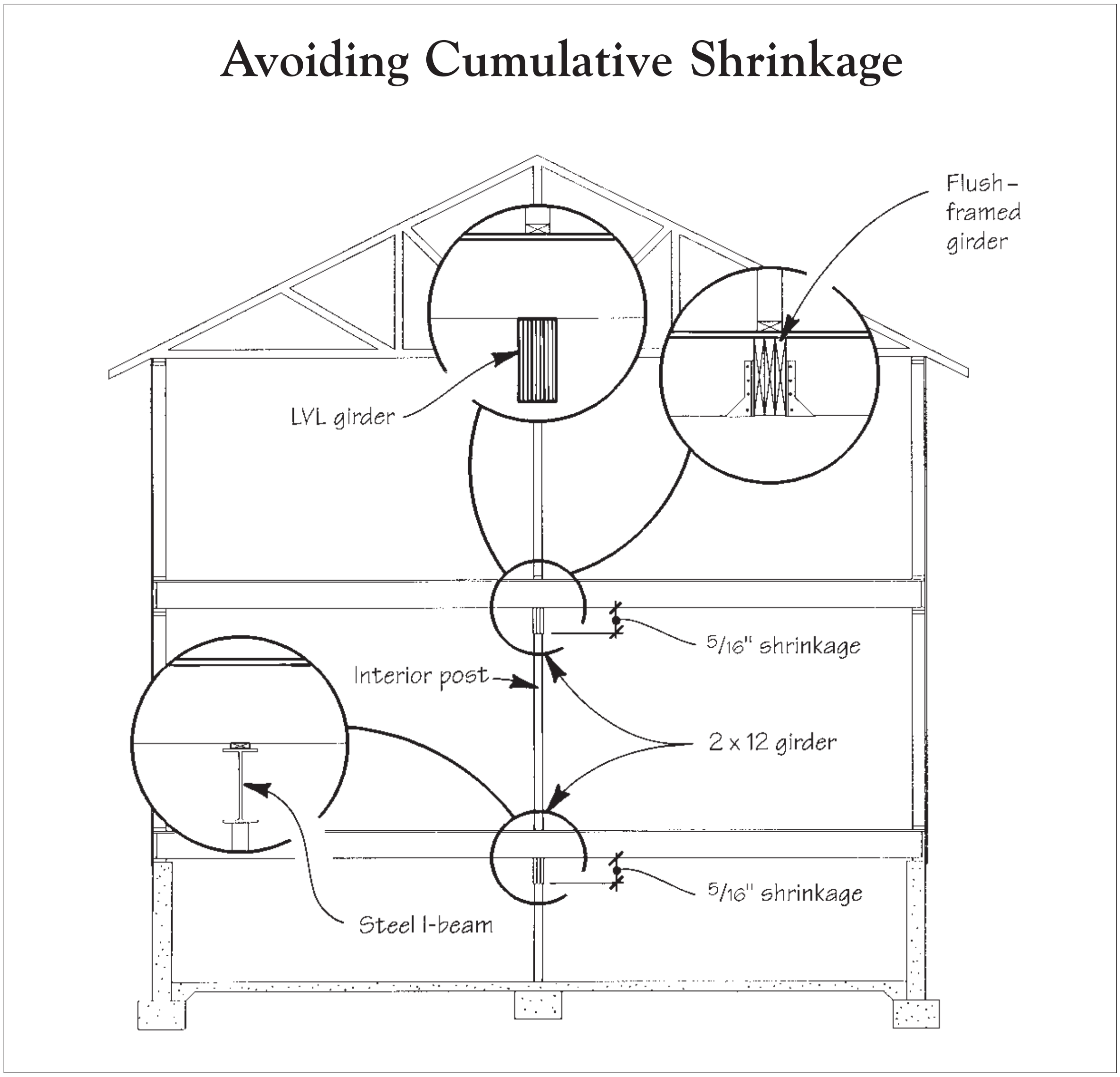


Figure 1. *Watch out for situations where wood shrinkage can compound to create noticeable problems. In the house shown here, the two built-up 2x12 girders will cause the center bearing wall to shrink much more than the exterior walls. This will result in a 1/2-inch drop at the second floor level — enough to cause nail pops and cracks in the finishes. Using a steel I-beam in the basement and engineered lumber or flush framing at the second floor will alleviate the problem.*

component — all of the joists in a floor, for instance — shrink the same amount.

Dry the Frame

Studs that are straight at 19% MC can do a lot of twisting and bowing as they dry to 8%. The U.S. Forest Products Lab (FPL) recommends that a frame be within 5% of its final moisture content before walls and ceilings are closed in. At the company I work for, we try to dry the frame to 10% or 12% MC before installing drywall or plaster. This gives us a chance to fix or replace any pieces that bow.

In cold weather, drying the frame may require some heat. A few winters back, I used a moisture meter to record how long it took the frame of a house I was working on to dry out. It was cold, but the humidity was low and the house was weathertight. After three weeks, most of the frame was stuck at 15%. We then set up an old gas furnace as a temporary heater. A week and half later, everything had dried to around 10%. Of course, it's not cheap to use heat to dry out a house. But if you're doing a high-end job, it beats coming back later to repair drywall, tile, and trim. And the heat doesn't have to be all that high. The FPL says that you need only keep the inside of the building 10 to 15 degrees warmer than the outside.

Pay Attention to Framing Details

Even if you purchase high-quality framing lumber and protect it after it arrives, you still won't be able to prevent the wood from shrinking altogether. But if you use framing details that *allow* for the shrinkage, you will avoid most of the problems that can occur when the frame shrinks.

Problems occur when one side of the building has considerably more headers and plates than the other side, when there's an improper connection to masonry, or when solid lumber is mixed with steel or engineered lumber without compensating for the materials' different shrinkage rates. The symptoms include sloping floors, and lumps and dips in floors and walls. Although this sounds complicated, it's fairly easy to design a frame that will shrink evenly.

Avoid Lopsided Shrinkage

It's important to recognize situations when a structure will shrink unevenly. Look at the example in Figure 1. Here, the first-floor joists are supported by a built-up 2x12 girder. The upstairs features an open floor plan, with the second-floor joists also resting on a 2x12 girder.

The problem with this configuration is that the two girders may shrink as much as 5/16 inch each as the lumber

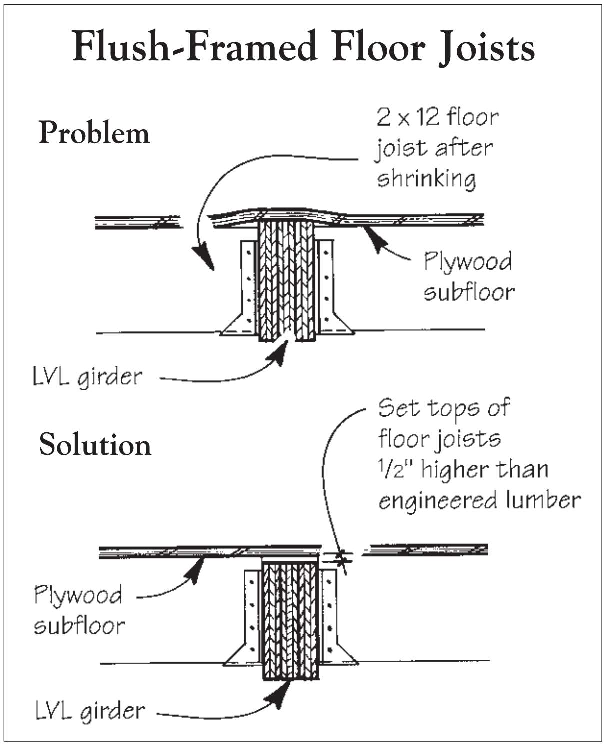


Figure 2. *Floor joists laid flush with the top of engineered or steel beams will create a bump in the floor when they shrink (top drawing, left). In these situations, install the joists 1/2 inch high to accommodate the anticipated shrinkage (bottom drawing, left). Where I-joists meet an engineered lumber beam (above), you can install them flush since shrinkage is not an issue with I-joists.*

dries from 19% moisture content to 8%. This is much more than the shrinkage that would occur in the exterior walls. The first-story ceiling and the second-story floor will then drop by 1/2 inch or more, wreaking havoc with the drywall finish and possibly leaving noticeable dips in the floor.

The solution is to use girder material that doesn't shrink — either steel or LVL — or to flush-frame the girders.

Whenever you're flush-framing a floor system where solid wood joists meet an engineered lumber or steel beam, don't set the tops of the joists exactly even with the top of the beam (Figure 2). Otherwise, when the joists shrink, they'll leave a bump in the floor. When I'm faced with this situation, I drop the beam approximately 1/2 inch in relation to the joists, so the joists can shrink without the top of the beam contacting the subfloor.

Foundation Details

Some designs call for the first-floor joists to bear on an interior foundation ledge, as in Figure 3. The problem here is that when the joists shrink, the ends pull away from the subfloor, leaving a slope at the exterior wall. I once installed a refrigerator in a kitchen that was framed this way; the floor sloped so badly that I couldn't level the refrigerator with the leveling feet.

A better detail is to keep the subfloor off of the sill plate. When the floor joists shrink, the subfloor will move with them. When installing a wood floor, you can prevent a gap from opening beneath the baseboard by installing the flooring after the baseboard and using a shoe mold that's attached to the floor.

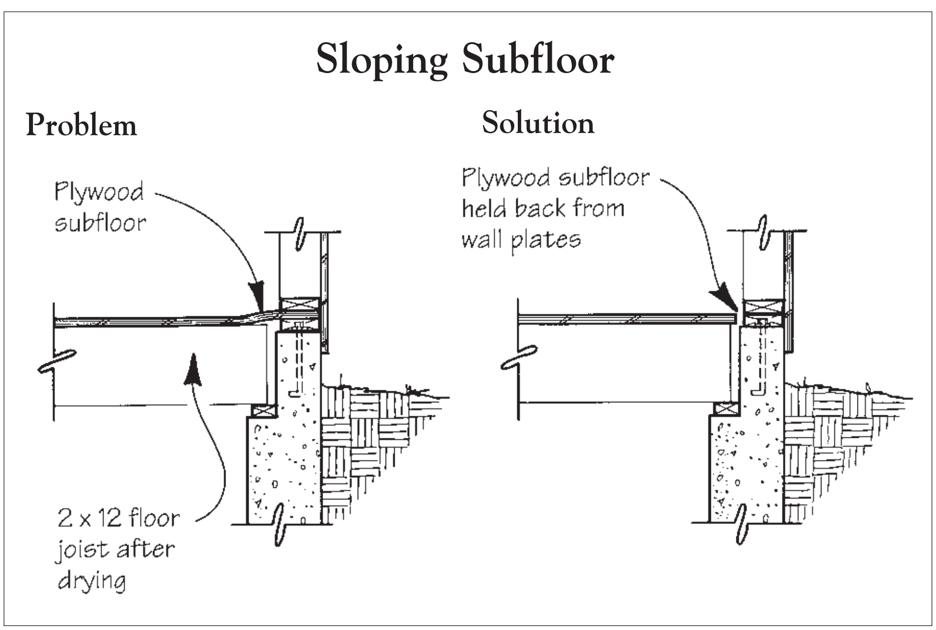


Figure 3. *Subflooring that is installed underneath the exterior wall framing (left) will cause a slope as the floor joists shrink. Where floor joists bear on a foundation ledge, the subflooring should stop short of the exterior wall (right). This allows the subfloor to move with the joists as they shrink.*

Where Wood Meets Masonry

If the framing isn't dry when a concrete hearth is poured, the framing will shrink so that the hardwood floor surface ends up slightly below the hearth. Because hearths are usually set late in the job, after the framing has had time to dry, this is seldom a problem. But if the hearth is set earlier — or if cold weather prevents the frame from drying — you should anticipate shrinkage and set the hearth a bit lower. ■

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