Water in the Walls: Three Case Studies

Moisture is one of the worst enemies of wood-framed buildings. The trend toward tighter, more energy-efficient houses has made it important for builders to understand how moisture behaves and to plan ways for the house to handle moisture. Increased insulation levels and better air-sealing techniques have lengthened the time needed for the air in these homes to be replaced by natural infiltration. As a result, water vapor from showering, cooking, plants, people, and pets lingers indoors longer than it does in older, leakier homes, while the moisture trapped in new framing lumber escapes more slowly. This paves the way for mildew, mold, decay fungi, and insects. (See "Wood Fungi Causes and Cures," 5/93, and "Wood-Destroying Insects," 5/92.)

You can avoid these problems by using kiln-dried framing lumber and mechanically venting water vapor directly to the outside before it does any damage. As these three case studies show, failure to do so can lead to disaster.

Case 1: Bathroom Moisture Recipe for Decay

While renovating a bathroom in their 22-year-old home, the owners were shocked to find wet insulation, severely decayed framing and sheathing, and live carpenter ants behind the tiled shower stall (Figure 1). Tucked into an outside corner, two sides of the stall were against exterior walls. The walls consisted of floor-to-ceiling ceramic tiles set on mortar and metal lath, standard gypsum wallboard, unfaced fiberglass batt insulation between 2x4 studs, plywood sheathing, and wood shingles. The bathroom had a window, but no exhaust fan.

The shower pan and drain tested leakfree, and the owners recalled that the tiles and grout had only a few cracks. This told me that the cause of the problem was not liquid water leaking into the walls. Instead, a construction error — omission of a vapor retarder behind the wallboard — had let water vapor diffuse into the wall cavity. Lack of an exhaust fan also allowed water vapor and liquid condensation generated by showering to persist in the bathroom. This increased the chance that the moisture would get into the walls through hidden air leakage paths, then condense and freeze on the cold sheathing. When it melted in warmer weather, the liquid water increased the moisture content of framing and sheathing to the 28% threshold required for decay. Carpenter ants followed.

My diagnosis was confirmed by the run-down staining on the home's white shingles outside and below the second floor bathroom. The owners remarked that despite washing the streaks off each summer, they always reappeared the following spring.

To prevent future problems, I recommended that they add a vapor retarder to the warm side of the exterior wall and install a bath exhaust fan vented directly to the outside. Running the fan would reduce the amount of moisture infiltrating into the wall to a negligible amount.

Figure 1. *The framing behind this shower stall (above) rotted because bathroom moisture leaked into the walls. The excess moisture also caused extractive staining on the home's siding (right). The solution was to add a bath fan that vented moisture directly to the outside.*

Poor ventilation, shoddy vapor sealing, and green lumber can lead to serious structural and appearance problems

by Stephen Smulski

Case 2: Indoor Humidity Causes Exterior Stains

A contractor was living with his family in an unsold spec house he had built ten months before. When numerous red-brown streaks appeared at random on the home's white siding in February, he complained to his supplier that the siding was defective. The streaks appeared on all sides of the house, but were worse around the windows and outside the master bath.

The contractor had sided the home with 1x6 clear heart, vertical-grain western red cedar bevel siding. The siding had been machine-primed on all sides with a stain-blocking primer and field-coated with two topcoats of a solid color exterior white stain. The wall construction was typical of a modern energy-efficient home: gypsum wallboard, a polyethylene vapor retarder, unfaced fiberglass batt insulation between 2x6 studs, plywood sheathing, an exterior air infiltration barrier, and the siding.

The dark streaks were what most contractors call "cedar bleed," though a more accurate term is "run-down extractive staining." It's a problem with redwood and red cedar, and shows up occasionally on Douglas fir and southern pine as well. Happening commonly during late winter, run-down staining occurs when liquid water — in this case water vapor from inside the home that leaked through wall cavities and condensed on the cold siding — wets the back of the siding for a prolonged period. Eventually, the water penetrates the primer, causing the wood's water-soluble extractives to leach out. The dark brown solution then seeps out from behind the siding through the overlap between courses, dripping down and discoloring the face of the courses below.

During my inspection, I found live mold on some joists and stair stringers in the basement. I wasn't too surprised, given the fact that basement relative humidity and wood moisture content (62% and 12%, respectively) were more typical of June than February. Relative humidity on the first and second floors (46%), was also much higher than the 25% to 35% typical for this time of year.

Figure 2. *Water vapor from inside this new house — caused in part by green framing lumber and a dryer vented directly into the basement — leaked through the walls and caused extractive staining on the primed and painted siding (below).*

When I removed the siding in a heavily stained area, I found liquid water and extractive staining on its backside (see Figure 2). Water also saturated the plywood sheathing behind the wet and stained air infiltration barrier. Siding, sheathing, and framing checked in at 33%, 50%, and 30% moisture content, respectively,

instead of the 12% to 15% that I would have expected. Though I found no decay, conditions were ripe for rot. The reason rot hadn't yet taken hold was that it was simply too cold outside.

The cause of the wet siding was excessive indoor humidity. Sources included a humidifier on each of the home's two forced-hot-air heating systems, a clothes dryer vented into the basement, four bathroom exhaust fans vented into the attic, a recirculating-type kitchen range fan and, as shown by the S-GRN grade stamps, green framing lumber. Despite the weight of this evidence, the contractor insisted that the water vapor from inside his "tight" house couldn't be leaking through the walls. Not until I pointed out that there was no staining whatsoever on the attached garage did he finally come around.

The solution to the staining problem was simple: lower the indoor relative humidity. To do so, I recommended that the builder disconnect the humidifiers and vent the clothes dryer, bath exhaust fans and kitchen range directly to the outside. Stains could be removed later by washing the siding with a dilute solution of oxalic acid (available from paint or hardware stores) once the framing, sheathing, and siding had dried to below 19% moisture content. Repainting with a stain-resistant primer would complete the job.

Case 3: Green Timbers Spawn Decay

While adding a porch to their six-year-old hemlock timber-frame home, the owners found extensive decay in the corner posts. After removing more siding and trim, they found at least minor decay wherever the timbers contacted studs and sheathing.

The builder had framed conventional 2x6 walls between the posts and sheathed them with plywood. From inside to outside, the walls consisted of gypsum wallboard, a polyethylene vapor retarder, unfaced fiberglass batt insulation, plywood sheathing, rigid foam insulation, and wood siding. The studs were fastened directly to the faces of the posts.

Built-in during construction, the source of the decay-causing moisture was the huge gallonage of water trapped in the green (water-saturated) timbers. In an effort to make the house energy-efficient, the builder had boxed the timbers in on three faces with studs, sheathing, and rigid foam (Figure 3). This had severely retarded the drying of the timbers. As a result, the wood stayed at a decay-susceptible moisture content for years after closing-in. The timbers were forced to dry through the one face exposed inside the home. Corner posts were especially slow to dry because of the tiny exposed surface area.

An 8-foot-long hemlock 8x8 contains about nine gallons of water when green (about 97% moisture content). When it eventually dries to the 12% moisture content typical of framing in heated buildings, it will contain about one gallon of water. The other eight gallons will have been released into the air or the surrounding materials. The total water given off by a green frame counts in the hundreds of gallons, with the greatest release occurring during the first heating season. In fact, the owners of this home recalled a "Niagara Falls" of window condensation that damaged sashes, sills, and walls for the first three winters of occupancy. They actually put towels on the window sills to sop up the flow.

Fortunately, enough of the corner posts' cross-section was still sound enough to make reinforcement or replacement unnecessary. Following my recommendations, the builder replaced the decayed studs and sheathing, and treated the timbers with a waterborne borate preservative to kill existing decay and prevent future infection.

This problem could have been avoided. One option would have been to use partially air-dried timbers or to use salvaged timbers that had dried in place years before. Another would have been to use naturally decay-resistant timbers. Hemlock and red oak have no resistance to decay; white oak has very high natural resistance; eastern white pine has moderate resistance. You can virtually eliminate the decay risk of any species by applying foam-core stress-skin panels to the outside of the timber frame. This leaves three faces exposed on the inside, which provides an escape route for water and promotes faster drying. ■

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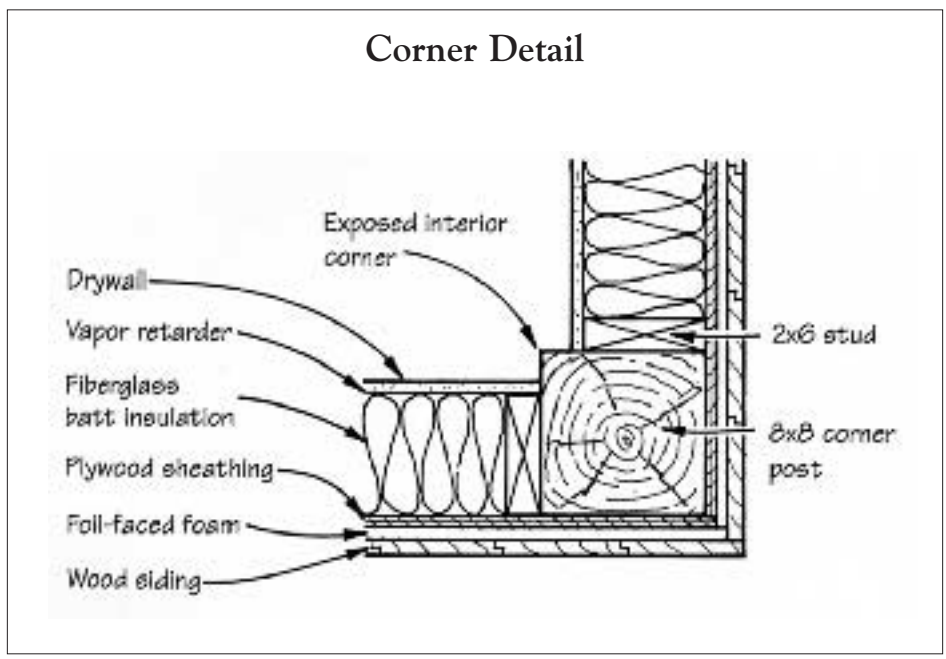

Figure 3. *While remodeling their six-year-old timber-frame home, the owners found that the corner posts had decayed along the outside edge. The builder had boxed in the green timbers with framing and sheathing, holding the wood at a decay-susceptible moisture content for years after closing-in. Drying could only take place through the one exposed corner.*