

ROOF VENTILATION RETROFIT

by Henri de Marne



Workers tear off rotten sheathing over an unvented cathedral ceiling.

The debate between proponents of unventilated “hot” roofs and ventilated “cold” roofs has been raging for years. Hot roof advocates argue for sealing all wall penetrations against convection (at outlets and vents stacks, for instance) and applying a perfect vapor barrier. They claim that these measures keep moisture from entering rafter bays, thus eliminating the need for a ventilating air space between the roof insulation and the sheathing.

Cold roof advocates like me admit that it is theoretically possible to build an unventilated roof, but caution that it is almost impossible in practice to build it to perfection. The most conscientious builder will still have trouble installing insulation, caulking, and vapor barriers to the high standards required by the hot roof system. Even if the job is perfect the day it is completed, seasonal movement of the building frame and finish materials virtually guarantee that moisture will eventually find its way into the roof cavities. Without a ventilating air space, this moisture has no means of escape and wreaks havoc with the structure.

Of course, cold roofs are not perfect, either. But in my opinion, building an attic or cathedral ceiling without ventilation is an invitation to an expensive repair job.

Case in Point

One such case, among quite a number I have worked on in my construction consulting practice, involved a poorly ventilated roof that resulted in the worst structural damage I have ever seen. The house is a two-story contemporary with two second-floor bedrooms capped by a flat ceiling with an attic above. The main feature is a long, steeply pitched cathedral ceiling over the first-floor living room that changes to a shallower pitch over the second-floor master bedroom. The master bedroom and one other rear bedroom overhang the first story by about 4 feet.

Telltale stains. I was first called to the site in 1987, one year after the house was built, to find the cause of water stains on the cathedral ceilings. One glance was all I needed to know that they were caused by condensation on the underside of the roof. To confirm my suspicions, I first looked in the attic. There were water stains on the sides of the rafters, and mold was growing on the plywood sheathing. The obvious cause of the moisture buildup was a lack of ventila-

When flawed air and vapor barriers caused this roof to decay, a new venting system was the answer



Figure 1. Moisture trapped in the attic raised the moisture content of the wood to well over 20%. Vigorous growth of several types of fungi turned the underside of the roof sheathing completely black.



Figure 2. At the cathedral ceilings, both the roof sheathing (right) and rafters were rotted and crumbling.

tion. The builder had installed a single 4-inch-diameter mini-louver in every other rafter bay, and only in one set of eaves. With so little air entering the soffits, the ridge vent was ineffective.

The cathedral roof had no ventilation whatsoever, so I suspected the moisture problem was at least as bad. There was no easy way to inspect the rafter bays, but I was able to inspect the roof from outside. The roof was wavy in some places, indicating that the plywood had swelled with moisture and was buckling.

The obvious answer to the attic problem was to provide needed ventilation by installing continuous ridge and soffit vents. Adding ventilation to the cathedral roofs, however, would be difficult and expensive, because I assumed that there was not enough uninterrupted space for air circulation above the insulation. That would mean opening up the whole roof, because the rafters over the living room were well over 20 feet long. So I offered an alternative solution of sealing drywall cracks from the inside and painting with low-perm paint.

Too little too late. Several years later, after the original owners had moved away and the house was put up for sale by a relocation company, the prospective buyers called me in to do an inspection. The broker had disclosed that the original builder had disregarded my original diagnosis, claiming instead that the water stains on the cathedral ceilings were caused by moisture migrating from the attic. His solution was to clear the space around the mini-louvers, which he claimed had been plugged with fiber-

glass by mice, and to install additional louvers in the soffit.

When the problem persisted, the original owner had suggested that there might be a flashing leak where the long living room roof plane met the exterior wall of the second story. The broker had hired a second builder to install step flashing over the existing continuous flashing to stop the leak.

In 1991, however — the first winter the new owners spent in the house — the water stains were back. Obviously, the problem had not been solved, so I was asked in March of 1991 to take a second look. At that time the house was less than five years old.

What I found in the attic was beyond belief. The attic rafters were stained far worse than I remembered. But when I looked at the discolored roof plywood, my first thought was that someone had sprayed the sheathing with matte black paint (see Figure 1). Later, in helping to prepare the owner's lawsuit, I scraped off some samples and sent them to two wood toxicologists to have them assessed. The tests confirmed what I already knew: The several types of fungi flourishing on the sheathing were precursors to decay-causing fungi, and required over 20% moisture content in the wood to grow.

The staining on the interior drywall on the cathedral ceilings had also worsened. From the outside, the buckling of the plywood sheathing seemed more pronounced as well.

Seeing is believing. The original builder was still unconvinced, and the matter soon landed in the hands of a

lawyer retained by the new owners. After many months of negotiating between attorneys, the builder agreed to open the roof wherever I directed, to prove, as he put it, that I was wrong. In making the venting repairs, he had removed part of the rear soffit, and noted that the rafter tails and sheathing looked as good as when he built the house.

We all met late in October 1991 to open the roof. Even before the shingles were completely removed, I knew there was serious decay because the nails gave almost no resistance. The same was true of the sheathing nails.

The plywood, once exposed, was discolored and deteriorated, and was also quite soft. When the last of the nails was removed and the carpenter lifted the piece of plywood up on edge, it was so rotten, it literally sank into the rafters by a couple of inches (Figure 2). The underside was soaking wet and blotchy — black in places and white in others — from a variety of molds. The top 2 inches of the exposed rafters were also rotten. A second later, hundreds of carpenter ants rushed up out of the framing and scattered across the damp insulation.

That winter, thick ice dams built up at the eaves (Figure 3). Water backed up into the structure, and ran down the outside wall and back along the cantilevered floor joists, finally exiting and freezing between clapboards on the first-floor wall. Water also ran steadily onto the floor of both upstairs bedrooms, soaking the carpet at least 4 feet into the room. When I went to look at the damage, I found the carpet pulled back and



Figure 3. The winter before repairs were made, huge ice dams formed at the eaves of this cathedral roof. Water backed up into the soffits and walls, soaking interior and exterior finish materials.



Figure 4. High moisture in the cathedral roofs created a perfect environment for carpenter ants, which tunneled into the insulation and nested in cracks between framing members.

rolled up to the middle of the rooms. The owners had several fans running in an attempt to dry the wet plywood sub-floor, which nevertheless still had to be mopped up periodically. In short, the rooms were unusable.

Cold Roof Remedy

All negotiations over the winter were fruitless, but the need for repairs was now urgent. I wrote specs for the repair and when a new contractor was hired, I was asked to document and verify both the damage and the repairs.

My specs called for the entire roof of the house to be removed. To avoid exposing too much of the interior at one time, the builder performed the repairs in sequence: the shallow cathedral roof, the attic roof, and finally the long cathedral roof over the living room.

All sheathing was removed from the attic roof, and the rafters were treated

with a fungicide and insecticide. New plywood and new shingles were installed, along with continuous ridge and soffit vents.

At the cathedral ceilings, most of the moisture damage was confined to within 8 feet of the ridge. Much of the plywood sheathing was so badly rotted that it broke into pieces while the nails were being removed and again when it was lifted off the rafters. Hundreds of carpenter ants had nested in cracks and seams between framing members, and had tunneled into the fiberglass insulation (Figure 4).

The top 2 inches of the rafters were also rotten; by contrast, the bottoms and lower two-thirds of the rafters' length were water-stained, but still sound. All of the fiberglass insulation was removed as a precaution against any remaining ant infestation. Before any new framing material was installed, the rotten parts

of the rafters were removed, and the entire area was treated with a fungicide and insecticide (Figure 5).

Cold roof. The cold roof design I specified is one I have used extensively in northern Vermont for nearly 20 years with great success (Figure 6). It has two purposes: to prevent — or at least to reduce — snow melt and the resulting ice dams by keeping the underside of the sheathing cold; and to give any moisture-laden warm air an escape route through the air space and out the ridge vent.

To reinforce the rafters and to provide for a continuous air space below the new sheathing, 2x8 sister rafters were set 1½ inches above the top of the existing roof plane. On the sound wood of the lower roof section, 2x4 sleepers were centered and fastened flat to the top of the rafters to establish the new roof plane and maintain a continuous air space. The builder believed it was too difficult to do a good job of installing a poly vapor barrier in the bays from above. Instead, he taped the drywall joints with duct tape to prevent convection, then carefully installed new R-30 Kraft-faced insulation. The ceilings would be repainted with low-perm paint.

We opted for 1-inch-thick extruded polystyrene rigid foam insulation to keep the batts from expanding into the newly created air space. The rigid foam also added an additional R-5 to the roof, and its smooth surface provided less resistance to airflow than the fiberglass insulation. In the sistered area, the foam was held in place with a few nails tacked into



Figure 5. Before installing sister rafters and insulation, the existing framing was sprayed with a fungicide and insecticide.

Cold Roof Details

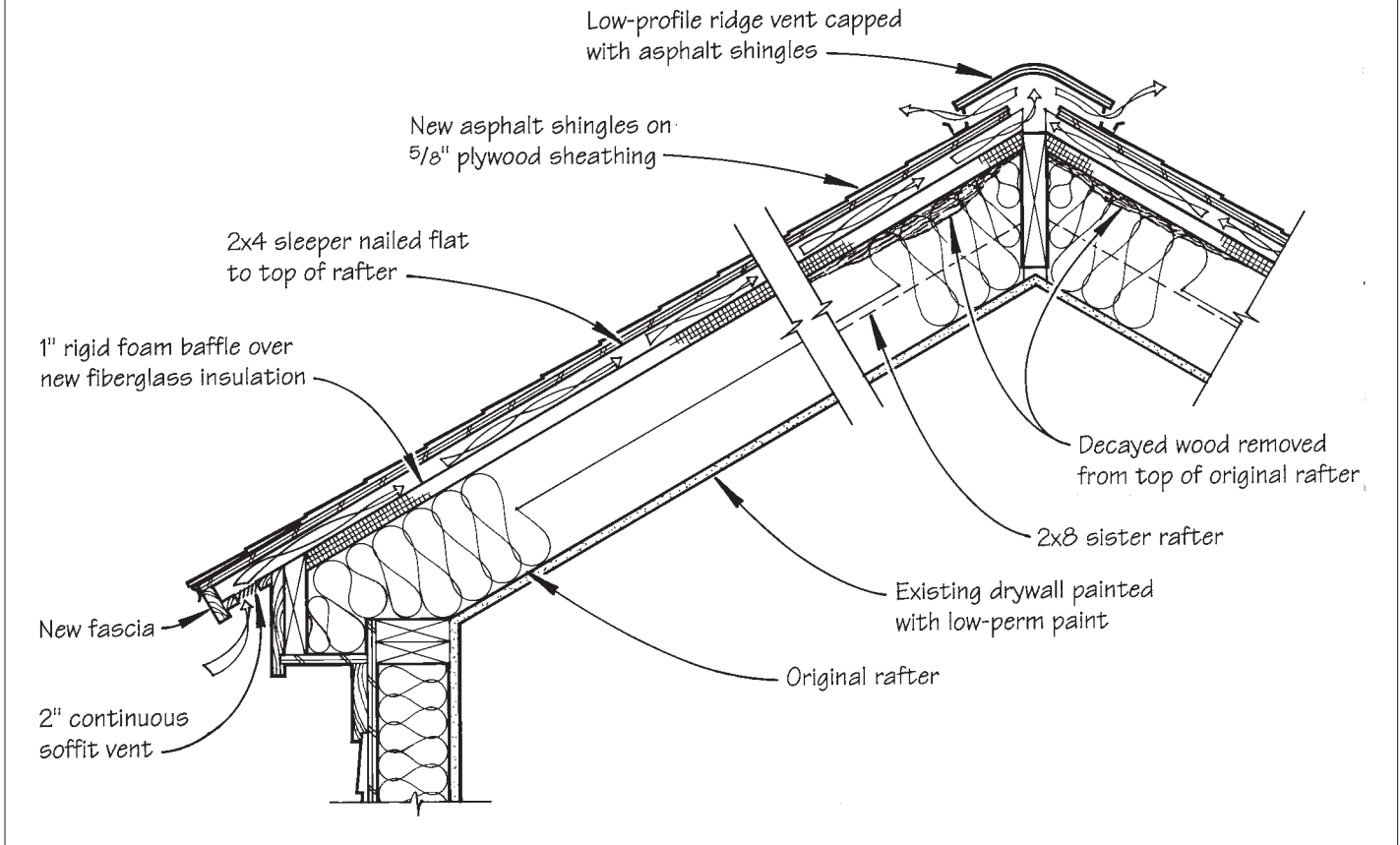


Figure 6. A cold roof is designed to maintain a minimum 1½-inch air space between the insulation and the roof sheathing. Continuous soffit and ridge vents carry away moisture-laden air, preventing condensation in the rafter bays.



Figure 7. Two-by-four sleepers on top of existing rafters provide a ventilation chute beneath the plywood sheathing, while 1-inch rigid foam insulation prevents the fiberglass batts from expanding into the air space.

the side of the rafters (Figure 7); in the area of the 2x4 sleepers, the overhang on each side of the rafter held the foam in place.

At the eaves, the sleepers extended beyond the existing fascia to allow for a 2-inch-wide continuous soffit vent. For a ridge vent at both the attic and cathedral ridges, I specified Shinglevent II, by Air Vent (Air Vent Inc., 4801 N. Prospect Rd., Peoria Heights, IL 61614; 800/247-8368). The vent has an external baffle to prevent snow and rain from infiltrating, and its low profile is designed for use with asphalt shingles (see "Low-Profile Ridge Vents," 5/92). Although I would have preferred a 4-inch air space over the long cathedral ceiling, this proved to be impractical because of the way the front roof intersected the two roof sections in the rear of the house. (Such a large air space would also have been too expensive because it required sister rafters throughout the cathedral ceilings.)

The new ventilated roof system has now been through its first winter, and appears to have solved the ice dam problem. Only time will tell if the continuous air space has solved the moisture problem in the ceilings. But I have used this solution so many times to solve similar, though less extreme, problems that I am confident the cold roof works.

The repairs to the roof cost \$12,331, plus \$500 for pesticide treatment, and \$1,500 to repaint the ceilings. In addition, the owners and the original builder incurred substantial legal and consulting fees. All of this waste of time, materials, and money could have been avoided had a proper cold roof been built right the first time. The alternative is not worth the risk. ■

A builder for nearly 30 years, Henri de Marne is a consultant in Waitsfield, Vt., specializing in moisture-related construction problems.