A Rotting Timber Frame

Foam sheathing, too much moisture, and a broken vapor barrier almost spelled disaster for a four-year-old timber-frame house in southern Vermont.

by Steven Bliss

"If you don't put in a vapor barrier, your house is going to rot away." You've heard this many times, but it's not so simple.

Thousands of insulated houses with no vapor barrier or a lousy vapor barrier such as kraft paper have not rotted away. Furthermore, sticking a sheet of poly in the wall is no guarantee against problems. Take the rotting timber-frame house that I visited in southern Vermont last November...

The 1,800-square-foot, 1-1/2-story Cape is four years old. The walls are framed with 8x8 timbers, which are exposed on the interior of the house. Between the 8x8s the builder framed-in with 2x4s to provide nailing and a place for fiberglass insulation. The frame was sheathed with one-inch boards, then wrapped with one-inch-thick, foil-faced isocyanurate, which was taped and caulked. Clapboard siding was installed over kraft paper (see diagram).

Rotting Beams

The owner discovered the problem when a renovation contractor opened up the south side of the house in order to add a sunspace. He found extensive decay in and around the timbers. The rot occurred on the outer face of the timbers—up to two inches deep in some sections—and in the sheathing and 2x4s wherever they touched the timbers.

To learn more, the owner cut out sections of siding and sheathing on all sides of the house and found decayed wood on the north, south, and west. Only one hole was cut on the east side, and showed only minor damage. There was decay on nearly all the beams looked at—high and low, on vertical posts, and on horizontal beams. But also occurred in the 2x4s that were directly nailed to the beams, and in the 1x pine sheathing where it touched the beams. No decay was found in the wall sections between the beams, or elsewhere—although a thorough search was not made of all areas.

Looking Further

When I visited the house in November, I looked for evidence of high moisture levels. It was a sunny day in the 40s—too warm for condensation to form on the windows. But all the second-floor windows—and most on the first floor—were badly stained from pooling condensation. The owner confirmed that condensation covered most of the windows for most of the winter. The sources of moisture were many. For the first two years, the house had a wet basement each spring. (This was finally cured by regrading around the foundation.) There were no bathroom or kitchen fans, and the dryer vented indoors. The beams were heavily checked on the inside (right) and rotting on the outside (left).

Decay was concentrated on the outer portion of the timbers and the nearby sheathing and studs, as shown in the darkened area.

The west face of the house (above) was cut open in four spots, all revealing severe decay of the timber frame and adjoining wood. The south east corner (below left) and center hole (below right) are shown close up.
Why Two Inches of Foam Are Better Than One

Insulating foam sheathing is becoming fairly common in cold climates. But in most cases, it violates the rule of thumb that the exterior of a building should be five times more permeable than the interior. This is particularly true with foamed-in-place insulation.

Some people argue that it’s all right to use insulating sheathing because it wets up the wall cavity through water vapor condensation. This is based on 40 percent relative humidity (R.H.) data for Madison, Wisc., run by the Forest Products Laboratory in Madison, Wis.

How can you gauge this for yourself? First, you need to calculate the dew point of the interior air during the winter. To be conservative, assume an indoor relative humidity of 50 percent. That gives you a dew point of about 32°F according to the chart.

Next, calculate how cold it must be outside before the inside surface of the sheathing will fall below the dew point. The inside surface of the sheathing is where condensation is most likely to occur. You can calculate the temperature at any point in the wall if you know the total R-value inside and outside that point. The temperature rise through the wall and the R-values are in direct proportion.

For example, in Wall A, when it’s 32°F outside, the temperature at the sheathing surface is 73°F if there are no interruptions in the vapor barrier—at an R-value of 8. If you add a cold side vapor barrier, it will fall below the dew point. The inside surface of the sheathing would be at 53°F—solidly above the dew point.

The Diagnosis

To what caused the problem? In short, a combination of green wood, a poor drying environment, and a cold climate. The timber-frame family built the house, but the wood felt wet. The large gaps in the 8x8s provided an easy path for moisture into the wall cavities. Other interruptions in the vapor barrier—at floor, ceiling, and electrical conduit—let more moisture into the wall cavities. The exposed inside sections of the beams dried, but the wet outer sections did not.

The exposed inside sections of the beams dried, but the outer sections featured enough water to dry the wood. The wood housed tear drop-shaped grains that had been assembled green in the fall and closed in during the winter. Since the wood does not dry well in the cold, it was probably still quite wet when wrapped in foam and the following spring. The worst was the green wood grain that the design and framing had hand started the first year.

Why didn’t the beams dry toward the inside of the house over the summer? They did—at least near the inside surfaces, which became severely checked. But when winter came, the high moisture levels in the house drove the moisture back into the beams toward the sheathing, where it condensed.

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Since the average winter temperature in most of central and northern New England is at or below 32°F, Wall A appears risky unless you use one of the more permeable rigid insulations (headboard or rigid fiberglass), or at least a perfect in-slab vapor barrier. That’s not a bad way to make it.