

Ice Dams Revisited

Those are indeed serious ice dams pictured on page 63 of the March issue (“An Ice Dam Analyzed”). There are problems with that roof, but also problems with the article.

Look at the melt/no melt graphs. Melting will occur only when heat gain at the roof surface/snow interface

exceeds heat lost to the environment; that’s a law. Given the conditions described — conduction loss only, R-30 roof insulation, an inside temperature of 74°F (!), and an interface temperature of 32°F — steady-state heat gain will be 1.4 Btu/hr/sf. Assuming uncompacted snow to have an R-value of 1 per inch, at a 4-inch depth there will be thermal equilibrium at 26°F, not 10°F as the graph indicates. At 12 inches, this will occur at 15°F, not -20°F.

There will be no melting at colder temperatures. For an R-60 roof, these points are 29°F and 24°F, not 20°F and 5°F as depicted.

So, while the range of potential melting and refreezing conditions is much narrower than described, could ice dams form from conduction losses through an R-30 roof? Yes, theoretically, if those conditions were sustained long enough. Take the central point of the “ripe for icing” bar in Figure 5 — say 26°F and 7 inches of snow cover. Net heat gain would be 0.5 Btu/hr/sf, and given the heat of fusion to melt ice of 144 Btu/lb, it would take 288 hours to create a pound of water per square foot of roof surface — less than 1/2 inch. It would require 12 days of sustained conditions, which didn’t happen.

Something was missed in the evaluation of those ice dams in Michigan — air leaks, can lights, or some other

big heat leak. The proposed rigid foam overlay will help fix it, but venting the roof assembly will only help hide it.

Scott Flipse

Scruffydog Construction
State College, Pa.

Author Jeffrey Hoffman responds: First, to recap the method described in the article, I used a steady-state model to calculate the depth of snow needed to initiate melting at the roof surface at a given outside temperature. I then compared the model with actual weather data to confirm that, according to the model, the right weather conditions existed to create the ice dams as photographed by the homeowners. Thermal imaging of the roof demonstrated no localized heat leaks and supported my conclusion that snow melting at the roof surface and the subsequent ice dams were caused by conductive heat loss through the inadequately insulated hot roof.

Instead of trying to define heat transfer rates, it is much simpler to model the ice dam scenario as I did. Specifically, when the interface temperature reaches 32°F, snow begins to melt. If that occurs when there is an outside temperature of less than 32°F, you have a situation where ice dams can occur. Exactly how much ice would be generated at the roof edge wasn’t within the scope of the study; however, using heat transfer rates to model the situation is not a good approach. The problem is that once the snow begins to melt, its R-value decreases significantly, just as the insulating value of a down jacket decreases when it gets wet. The roof assembly now sheds thermal energy until a new thermal equilibrium — a new steady state — is reached, at a colder temperature, given the lower R-value of the wet snow at the roof surface.

The situation becomes a “transient nonlinear” problem. I would have had to quantify how much energy was leaving the roof in the form of liquid water and how much continued to conduct through the snow to the outside air. Not only would the R-value change over time as more snow melted, but the R-value would change throughout the thickness of the snow, depending on how much became saturated with liquid water. I wouldn’t say it’s impossible to model, but it would be a challenge, and in the end, I wouldn’t have had a way to verify the model. By contrast,



KEEP 'EM COMING!

Letters must be signed and include the writer's address. JLC reserves the right to edit for grammar, length, and clarity. Mail to JLC, 186 Allen Brook Lane, Williston, VT 05495; or e-mail to jlc-editorial@hanleywood.com.



Letters

with the steady-state model, I was able to confirm the conditions where ice dams were likely and compare them with actual roof performance as observed by the homeowners.

Note that I used an R-value of 3 for dry snow (based upon Fundamentals of Heat and Mass Transfer, by Incropera and DeWitt) versus your assumed R-value of 1. Wetter snow can certainly have lower R-values, but light, loosely compacted snow is common in our area, and as an engineer I needed to use a realistic worst-case scenario. So, for example, using your simplified model, 4 inches of snow but an R-value of 3 per inch yields an outside temperature of 15.7°F needed to initiate melting at the interface. True, I reported 10°F in the study, but my model accounted for convection inside and outside the structure that changes the results. In the end, whether the accurate answer is 16°F or 10°F is moot, since both numbers support the main point of the article — that the insulating effects of snow on a hot roof can create ice dams over the wide range of weather conditions where this house is located.

Quantifying the amount of water melted

on the roof is an interesting topic, although as mentioned earlier, it's a transient nonlinear problem and your approach assumes a steady-state linear system. Still, I'll address your point, but with more accurate numbers.

If the snow-to-roof interface is at 32°F and melting is occurring, the heat transfer will be 1.4 Btu/hr/sf, as you calculated earlier — not 0.5 Btu/hr/sf. Using your approach, it would take only 102 hours to create the 1 pound, or roughly 1/2 inch, of liquid water. (Actually, for reasons I outlined above, it probably would occur faster, due to the decreasing R-value of the wet snow and the now "warm" roof's search for a new colder equilibrium.) But even at 102 hours, there's still plenty of time to generate ice dams here in Toivola, Mich., where winter starts in November and ends in April and it's not uncommon to receive more than 15 feet of snow. Six months, or roughly 4,000 hours, is plenty of time for that snow to melt and for ice dam conditions to occur.

Last, in this particular home used in the study, the ceiling was sealed and there were no can lights embedded in the roof. Heat

loss was relatively uniform over the entire roof, as indicated by the thermal images. The "big heat leak" was simply conduction through the roof.

Don't Forget the Eaves Membrane

While I understand that the story "An Ice Dam Analyzed" (3/10) was about how an engineer attacked this problem, I am curious about the original construction. Where is the Ice & Water Shield? Roofers — who have been burned by inadequate insulation in the homes they have roofed and reroofed, a problem over which they have no control — resorted years ago to installing self-adhering eaves membranes to mitigate damage from the inevitable ice dams that will occur. This is done in self-defense. If the customer didn't want to pay for the "proper" amount of membrane (2 feet up-slope of the inside wall line), then we either threw it in or declined the job. Why should a roofer get blamed for ice dams that are caused by inadequate insulation and ventilation?

All that being said, isn't Ice & Water Shield code everywhere? It sure is here in southern Wisconsin and northern Illinois, where I work.

Chris Skrzynecki
Salem, Wis.

Spreading Sunshine

Thanks to Ray Habenicht for his detailed description in the article "A Fiber-Cement Sunburst" (3/10). Our volunteer group built an adaptation of his design for a Habitat for Humanity house in Austin, Texas. It was tougher than we had expected, and took some reworking to do the overlapping correctly so that the narrow ends of the rays didn't build up 2 inches thick! A careful rereading of Ray's article got us back



on track.

The sunburst has gotten rave reviews, so we're planning to do another one in the same neighborhood in the fall; our greatest concern is house envy by the other Habitat homeowners in the area.

Jon Wells
Austin, Texas

Magic Vent Channels

I admire Jeffrey Hoffman's analytical approach to investigating a Michigan ice-damming problem (3/10). He concludes that "if the roof had been properly vented so that the underside of the sheathing remained at the outside temperature, the roof would theoretically generate ice dams only when it was exactly 32°F outside." That's a big if — especially since Hoffman's magic vent channels defy the laws of physics.

Letters

Vent channels in cathedral ceilings have never been shown to maintain the roof sheathing at the outside temperature. William Rose, a building scientist at the University of Illinois at Urbana-Champaign, has measured temperatures in ventilation channels above cathedral ceilings for years. Rose found that as air flows up the ventilation channel, its temperature rises. "It becomes apparent that venting can cool the lower section of a vented cathedral ceiling quite effectively, but the cooling effect is greatly reduced for the upper part of the cavity."

Rose still advises that, in areas prone to ice dams, cathedral ceilings should include ventilation channels. But it's important to realize the limitations of ventilation. Any expectation that ventilation can cool roof sheathing to the outside temperature is unrealistic.

Martin Holladay
Sheffield, Vt.

Editor Don Jackson responds: While three of the eight roof assemblies in William Rose's well-known ventilation study are cathedral ceiling assemblies, only one of those was ventilated, achieved simply by stapling a 10-inch batt into a 2x12 rafter bay and providing standard soffit and ridge venting. Since one of the main purposes of the study (as documented in Dr. Rose's paper "Measured Summer Values of Sheathing and Shingle Temperatures for Residential Attics and Cathedral Ceilings") was to measure the extent to which roof ventilation could reduce shingle temperatures in hot weather, I'm not sure the findings are relevant to a roof assembly designed to mitigate ice dams.

The insulated built-up roof proposed by Jeffrey Hoffman (bottom illustration, page 65) has been used successfully for many years across the snow belt to prevent ice buildup above cathedral ceilings (or, more often, above the ceiling of an upstairs

bedroom tucked under the slope of the rafters). In addition to providing adequate insulation, the assembly works by stopping air leaks from inside the house, thermally separating the roof sheathing from the insulated roof structure below, and allowing cold winter air to be drawn by the wind into the minimum 1½-inch vent space, through both ridge and soffit vents. For good measure, when the budget allows, many roofers will go with a metal roof, to help shed the snow. The technique was described in a feature by Henri de Marne ("Roof Ventilation Retrofit," 6/95) and has been revisited in JLC many times since.

Renovate, Reuse, and Rebuild

I agree completely with Mr. Marron of New Bern, N.C. ("Be Part of the Solution," *Letters*, 3/10). I've been frustrated with the lack of residential-construction ideas and solutions for us "normal" folk. Who in their right mind is going to commission me to build a new house when they can go out and buy a 4-year-old residence for less than half of what it would cost me to build? A huge percentage of my cost of construction comes from ridiculously intrusive new codes, permit fees, school fees, septic fees, engineering fees, environmental impact studies, and workers' comp — read: taxes! Yes, I realize that California is a completely ridiculous state when it comes to business climate and government intrusion. However, the rest of you should be aware: What happens here will creep into your neighborhood soon!

We need ways to renovate, reuse, and rebuild the thousands upon thousands of properties sitting there vacant, as Mr. Marron correctly observes. I, for one, would like to see *JLC* champion ideas to accomplish this task.

Marty Bolter
Groveland, Calif.