Photo: courtesy Rockwool

Why and How to Build an Insulated Overroof

Avoiding the condensation risk of a modern roof design

BY TRAVIS BRUNGARDT

Over the last few years, our firm has built several homes with clients and architects who favored more contemporary, "Mid-century-Modern" styles. These designs had rooflines and ceiling planes that met the clients' aesthetic tastes but left us with roof assemblies that did not align with our performance goals. When a low-slope roof or vaulted ceiling comes together with narrow fascia profiles, there is little depth in the roof assembly for adequate insulation. This frequently requires a series of concessions that wind up leaving the house underinsulated for comfort and efficiency, and even worse, at risk of water damage from condensation. For us, the most successful way to address this three-headed monster has been to provide an insulated overroof.

I chose to title this article "Why and How …" rather than with the traditional order of "how and why." This is because the why is so much more important than the how for these types of details. There are probably a dozen effective ways to flash a window opening, and people use these different approaches with great success every day because they understand *why* leaks happen. This same relationship holds true for many things in building and especially for the specific risks we have to address with these roof details. You can correctly solve for thermal and vapor control with different materials and methods as long as you fully understand why changing the type, location, or depth of the insulation moves the dew point or increases risk of condensation. "How" is variable, but "why" is constant.

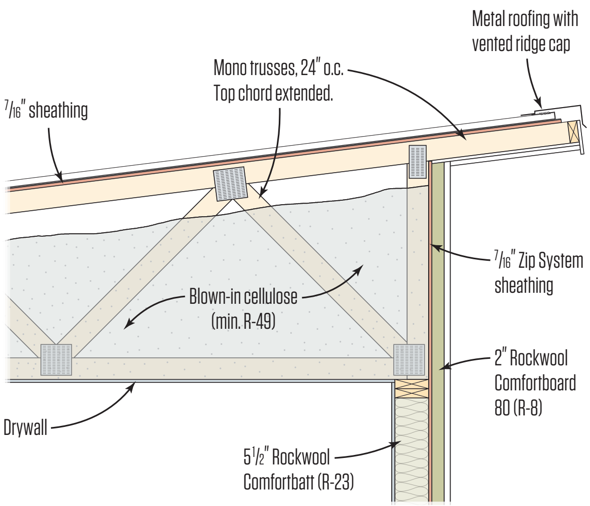
INSULATION SCHEDULE:

ALL INSULATION WILL MEET MINIMUM REQUIREMENTS AS SET FORTH IN IRC 2012 TABLE 1102.1.1, CLIMATE ZONE 4A.

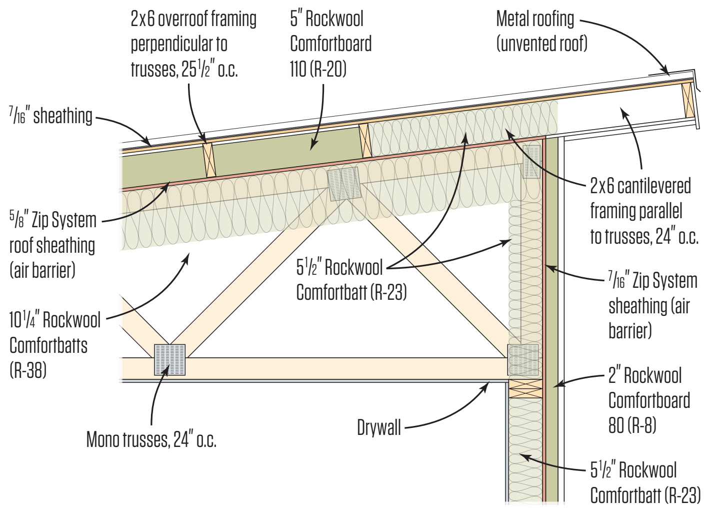
WALL INSULATION:	MINIMUM R-13 FIBERGLASS BATT OR MINIMUM 3.5 INCHES OPEN-CELL SPRAY FOAM INSULATION
ATTIC INSULATION: CEILINGS	MINIMUM R-48 BLOWN-IN INSULATION AT ALL FLAT
INSULATION IN VAULTED CEILINGS:	MINIMUM R-30 BATT
FLOORS THAT OVERHANG EXTERIOR WALLS & GARAGE	MINIMUM R-30 BATT

A couple of years ago, the author was asked to build this Midcentury Modern home. The roof framing did not allow adequate insulation for the climate, forcing him to spend an inordinate amount of time on air-sealing to avoid condensation problems.

Original Design



Overroof Solution



On a recent project, the author encountered another Midcentury Modern design (above left). He was successful in persuading the architect and client to adjust the design with a robust air barrier and an insulated overroof (above right).

Illustration: Tim Healey

THE LOW SLOPE/THIN FASCIA CONUNDRUM

A couple of years back, we built a large home with long, open spans, vaulted ceilings, and an I-joist roof structure that could accommodate only minimum code R-values of fiberglass insulation and no viable ventilation strategy (see excerpt from the plan set at the top of this page). The aesthetic desired by the architect and owner did not allow for a thicker roof edge or fascia to accommodate a greater depth of insulation, nor did they want to introduce a greater pitch to allow for stack-driven venting. Since the jurisdiction where the home was to be built was enforcing the 2012 IRC, the architect designed it to meet the code minimum R-38 for ceilings with a reduction to R-30 allowed for "Ceilings Without Attic Spaces." In the building code, this reduction is "limited to 500 sq. ft. of ceiling area." I've met a number of code officials in our area who read this as a reduction for each individual ceiling (room to room) rather than a reduction for the whole house, and that interpretation has resulted in an awful lot of woefully underperforming assemblies.

Having the minimum R-value and currently enforced code of the jurisdiction printed on the plan set has the unintended consequence of suggesting to all prospective bidders that building the home as designed would include R-30 fiberglass batts in an unvented roof. Of course, this creates an incorrect baseline of cost to the client in the competitive bidding process where all bidders include

Having completed the truss roof assembly (the "underroof), the framing crew built ladder **(1)** sections that would cantilever over the building line to create the narrow fascia essential to the Midcentury-Modern look. Between the overhanging sections, Joe Cook, the author's business partner, toenails on 2x6s running perpendicular to the truss frame **(2)**.

Photos: Travis Brungardt

the underperforming assembly in their estimate and then try to sell what should be the minimum as an upgrade after the fact.

To make a long story short, on this particular house, the client was not in favor of expanding the budget to arrive at our desired level of performance, nor were we involved in the process early enough to win over the architect and help "design out" this potentially problematic assembly. In this situation, we had to build the plan as designed, approved, and budgeted. We then worked around those fixed points with ambitious air-sealing in hopes of avoiding future problems. So far, so good, but we lost an obscene number of labor hours trying to make the airtight drywall lid work sufficiently to protect us from the condensation risk we fear. Meanwhile, the occupant will pay higher energy bills due to this underinsulated roof for as long as the home exists in this condition.

THE OVERROOF SOLUTION

When we were asked by another client to bid a smaller home in a similar design style a year later, we went to the architect straight away with our concerns about condensation. With their design team and our firm at the table, we went through the working drawings and raised those concerns, asked pointed questions, and eventually worked together to achieve a solution that didn't involve an unvented low-slope roof with fibrous insulation.

In lieu of a single roof assembly that achieved the vault and narrow roof edges that were desired, we suggested building two roof assemblies. One would use trusses, as originally intended, but without the generous overhangs as part of them. (On the original design, this was an extension of the top chord; see illustration on previous page.) On top of this truss assembly, we would then build an overroof structure that would cantilever beyond the exterior walls to achieve the narrow fascia profile.

Truss roof assembly. Having a lower truss assembly without overhangs would allow us to more conveniently (two less turns and much less material) use Zip System sheathing at the wall and over the "under" roof to accomplish our air barrier.

Overroof. Once the Zip System was complete, we would build an independent roof volume framed in 2x6s that could project beyond the building line. This created the narrow fascia profile desired and could be insulated with a vapor-open fibrous insulation.

Thermal control. We frequently self-perform insulation and air-sealing, rather than subbing it out, and for many years, we've used stone wool in our builds since it handles and cuts in a way more familiar to us as carpenters. Being able to instantly assess the quality of the insulation install without connection details being hidden behind a piece of Kraft paper is important. And we actually enjoy working with stone wool: It is gratifying to be able to fit it precisely, and it's reassuring to get both high performance and low risk.

Increasing rafter spacing to 25 1/2 inches on-center allowed for 2-foot-wide R-20 insulation boards. The only insulation cuts required were at the valley **(3)**. The ladder sections at the edges were framed 24 inches on-center to allow full shear nailing at sheathing edges where uplift and other forces are greater. These cavities were insulated with R-23 stone wool batts **(4)**.

Photos: courtesy Rockwool

Vapor control. Since Rockwool is our preferred material, we reached out to the company's building-science team to model the performance of the assembly we proposed with the 2x6 frame and 5-inch Comfortboard. Because Zip System is not impermeable, they identified a risk that vapor from the interior of the home could move into the overroof assembly and condense on the top layer of OSB. This is a risk our friend Ben Bogie had been warning us of, as well. To remove that risk, Rockwool suggested a peel-and-stick membrane over the underroof deck prior to framing the overroof.

The overroof solution met with the architect's approval (satisfying both aesthetic and performance goals), as well as our own as builders (high performance and low risk), so the last hurdle we needed to overcome was meeting the client's budget.

Selling performance. Usually if we simply pitch a second set of framing members and another layer of roof sheathing topped by yet another roof membrane, the added cost makes it pretty easy for most folks to reject it without much consideration. The first step in "selling" our solution was making sure everyone involved knew the potential risks and problems we might face if we didn't do the overroof.

With that baseline of understanding, we could then compare the overroof option against other options. These included an undesirable thickened roof edge and fascia profile to allow for sufficient free air that would equate to venting; the prospect of introducing a potentially riskier material like spray foam to this unvented assembly (see "Why Not Just 'Blow and Go,'" page 46); or the revision of the interior ceiling plane to allow for a traditionally vented attic and still meet desired R-value.

Compared to these options, the low-profile overroof solution stood out as the clear winner. As a value-add, the stone wool offered excellent noise reduction at the metal roof during rain and hail, a feature the clients were quite happy to hear about (or not hear, as it were). We were fortunate that these clients were already on board with prioritizing performance in their selections, including a smaller footprint overall, a Zehnder ERV, Alpen windows, a standing-seam metal roof, and exterior rainscreen. Our proposed revision fell in line with these planned house features. The architect provided a rendering of the assembly for approval, and we all agreed on this as the way forward. The Rockwool building-science team then verified the performance through WUFI modeling, and we reached an agreement on price with the client, so all we had left to do was build it.

THE BUILD

To keep costs low, we began by considering the actual labor steps for the assembly and prioritized the reduction of cuts and complexity. It would be slow to cut down rigid Comfortboard. This dense insulation board is sold in 2-, 4-, and 8-foot dimensions (actual), so in a conventionally framed assembly, it would have to be cut lengthwise to fit into 16- or 24-inch-on-center bays. To avoid this, we sought and won approval from our structural engineer to expand the spacing of our 2x6 overroof framing to 25 1/2 inches on-center. This would allow us to use full-width 2-foot Comfortboards, avoiding all insulation cuts except for one angled cut at the valley. This 45-degree cut could be used on each side of the valley, so we had only one cut for every 2 feet of travel up the roof. By starting at the valley, we would begin with that cut, place the Comfortboard in whole units, and then place a 2x6 firmly against this rigid insulation and toenail it into the truss below.

We ran the 2x6 overroof members perpendicular to the truss orientation. This limited our thermal bridging to a 1 1/2-inch square at each connection, rather than having a continuous thermal bridge along the entire length of each member. We could have eliminated the thermal bridge entirely by laying down a continuous layer of insulation boards over the roof and then running 1- or 2-by strapping as a nailer for the sheathing on top. This would have required securing the strapping with long screws into the truss chords below, which was less than ideal. We intended for this entire scope of work to be completed by our framing crew, and they want to fire nails from pneumatic guns, not drive long screws through multiple materials. But the main concern I had was that the long screws might not remain plumb through the depth of insulation and that they could miss the trusses entirely, or worse, catch the edge of a top chord and split the truss, which would require an engineered repair at every location this occurred.

To move fast, we needed to not cut, not screw, and not strap. Toenailing was allowed in the field to secure the 2x6 overroof frame to the trusses but the engineer did require a hurricane tie at each of the cantilevered overroof members where it extended out past the underroof. With the "two in, one out" ratio applied to the structural cantilever, we had our framers build ladder frames just like they would build walls—flat on the low-slope deck (see photo, page 44). They were then able to slide these frames out to overhang the lower roof assembly the appropriate distance, creating the narrow roof edge. This meant no ladder work to add to the cost of this detail.

To build out the overroof, we simply installed one line of 2x6s by standing on it to keep the board flat against the deck and toenailed

WHY NOT JUST "BLOW AND GO"?

Many builders address unvented "hot roofs" by simply choosing to install spray-foam insulation to the underside of the roof deck and relying on it to achieve sufficient R-value and manage airtightness in one step. There are a lot of homes built this way, and I understand that it is possible for this to be successful. Over the last decade we have used this approach ourselves when the design required it, but after locating numerous failures in these installations, we simply aren't confident in this approach in our market, and we seek to avoid it in favor of less risky alternatives.

The failures we have found have run a gamut: On our last five attempts with reputable installers, we have found numerous voids on visual inspections; incomplete application where the installer had apparently anticipated greater expansion than what actually occurred (example at right); mix-ratio issues, resulting in improperly cured foam; delamination or pulling away from framing members, which created gaps where air and vapor can travel and accumulate; and, of course, many cavities simply being underfilled so that the desired R-value is never achieved. We've had many insulators tell us that roof decks need open-cell foam, so that leaks in the roof can flow through to the drywall beneath and signal their presence to clients, and we've had just as many tell us that closed-cell foam is the only way to go on a roof deck, so that water vapor from the interior can't get into the foam, be trapped under the roofing materials, and rot the roof sheathing.

I tend to defer to Building Science Corp. and the wisdom of Joe Lstiburek, who has been on record since 2014 saying that the closed-cell foam is less risky at roof decks in cold climates, that open cell is too vapor open for use at roof decks, and that the whole "it saves your roof by showing you the leak" thing is bogus, as there's no data to support it. Given all that, I will simply say that while I believe spray foam can be a path to success, I haven't seen it executed successfully in my market, and I will avoid that risk whenever I can. —*T.B.*

Photo: Travis Brungardt

The author uses commodity OSB to sheathe the overroof. Once covered with a peel-and-stick synthetic underlayment and metal roofing, the assembly is sound **(5)**. The truss-frame underroof was insulated with R-38 stone wool batts **(6)**, resulting in a nominal R-58 for the lid of the home. Combined with the rigorous air barrier, the assembly avoids any condensation risk.

it to the truss below. We then laid down a piece of insulation, made the valley cut, and finished the line of insulation, pushing each insulation board snug against the 2x6. Then, we installed the next line of 2x6s, pushing them snug against the insulation. After that first 45-degree cut at the valley, there was no measuring or cutting the insulation or framing members until reaching the opposite roof edge where we would cut the 2x6 to the correct length. We would let the insulation "run wild" past the edge of the exterior wall below to complete the thermal boundary.

While the engineer had been agreeable to the toenailing and 25 1/2-inch-on-center framing in the field, he required that we stay 24 inches on-center for the ladder-framed cantilever sections in order to provide better shear nailing on the sheathing.

The sheathing in the field over the 25 1/2-inch-on-center framing did not always align on the framing. In those places, we "spliced" panels together by laying down a scrap of 1/2-inch OSB on top of the insulation and nailing any sheathing edges that didn't fall on framing into this scrap. (The Comfortboard is 5 inches thick, allowing just enough space for the scrap in the 2x6 cavity.) While this was sufficient in the field, this was not an approach the engineer approved at the edges of the roof, where uplift and other forces are greater.

The 24-inch cavities at the edges were insulated with R-23 stone wool batts, which are made to fit the 24-inch-on-center cavity. These offered slightly more R-value than the 5-inch, R-20 Comfortboard. This meant walking joists at the edges, which was slightly slower than what we enjoyed in the field. The Comfortboard we used has a compressive strength of 110 psi, so we could walk on it with virtually no give. Sheathing the roof with commodity OSB saved us a little money, and because we covered it with a peel-and-stick synthetic underlayment and metal roofing, we weren't sacrificing any durability. Even with the time we took to shoot video and photos, we completed the framed, insulated, and sheathed overroof in two days. The client and architect are thrilled, and my team can rest easy knowing we don't have any condensation risks.

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Photos: Travis Brungardt