BUILDING CUSTOM Sunrooms

by Dennis Bates

Combining a glulam frame with a watertight glazing system creates a good-looking, trouble-free sunroom

Since the mid-1980s, I've installed well over 100 custom sunrooms in Vermont. I like to build rooms that are versatile — where plants can be grown and where energy efficiency is good enough for affordable four-season use. While each sunroom I build is custom sized and finished, all of them take advantage of the same durable, reliable aluminum glazing system I've developed.

My most popular design is a basic shed addition, using a glulam frame that hangs on a ledger attached to a house wall. These shed sunrooms typically have fixed glass that runs up most of the vertical front wall and a third to half of the roof. This is a compromise between a roof covered completely with glass and a roof with no glass. The first maximizes sunlight exposure, but can lead to excessive summer heat gain and winter heat loss. The second holds heat better and is less likely to overheat in summer, but doesn't let in as much light. The endwalls usually have operable windows and doors that match the existing house. Because I often place conventional skylights in the unglazed upper portion of a roof, I keep the pitch at 4/12 (18 degrees) or steeper to meet the requirements of standard skylight flashing packages.

Shop Work

I use glulam beams because they are about twice as strong as most solid-sawn lumber, come in appearance grades, and are kiln-dried. Their dimensional stability ensures correctly sized glass openings. With fixed glass there's no such thing as rough openings — the openings have to be right on the money.

Columns and rafters. I find it most efficient to cut, sand, and finish glulam beams in my workshop. After a customer decides on the size of the sunroom, I size the beams and calculate the column, rafter, and purlin lengths. I use the same 3x5$^{1}/_{4}$-inch glulam stock for the rafters and columns of all my sunrooms, regardless of size. Unless the slab foundation is badly out of level, I can accurately cut the entire frame right in the shop.

As I cut beams, I look over each piece carefully and try to position any defects so that they end up high on a ceiling or low on a column. Customers love the look of glulam beams, as long as they don't end up with a finger joint or filler patch right at eye level.

At the site, each rafter will be bolted to the corresponding column and raised as a unit. The bottom end of each rafter must be predrilled to accept the pair of 8-inch lag screws that secure it to the corresponding column. Each hole has to be countersunk so that only the unthreaded collar of each lag screw remains in the rafter after fastening. It's also important that the countersunk hole is large enough for a deep socket to fit into it to tighten the lag screw.

The countersunk holes need to be centered carefully. To accurately pilot a hole through a rafter and into a column, I clamp the two pieces together. After drilling the holes, I temporarily bolt the assembly together with an electric impact wrench. I then round over all the inside edges with a router, run a random-orbit sander over the joint, and take the pieces apart for finishing. Most customers want the beams stained and then protected with polyurethane so that the natural look of the wood is visible.

Ledger and hangers. The ledger that supports the rafters is built up from two pieces of 5/4 pine, which I glue together with yellow wood glue. After the glue has set, I rip the top edge to the angle of the roof pitch, clean the exposed bottom edge with a power plane, and round the outer edge with a router.

The rafters are attached to the ledger with L-shaped hangers, which a local welding shop fabricates for me from 1/4-inch mild steel. To save time on site, I attach the hangers to the rafters in the shop, using eight or ten 4-inch #12 square-drive screws. Because these hangers project from the end of the rafter, I also rout out matching seats into the ledger to ensure a tight connection at the ledger. When the horizontal leg of the hanger is bolted to the ledger, the fasteners are completely concealed.

Installing the Glulam Frame

Whether the sunroom will be built on slab or on a framed subfloor, the basic layout rules are the same. The first task is to attach the ledger to the house wall. We always string the ledger, and shim it to account for any unevenness in the house wall. After the ledger is securely lagged, we carry plumb marks down from each end to the floor. We then extend layout marks to the front corners of the floor to mark the front edge of the columns. The frame has been cut to leave a 1 1/4-inch space beyond the front face of the columns, which corresponds to the 1-inch thickness of the glass units I use, plus the 1/4-inch foam glazing tape between the glass and the beams.

When locating the columns, square and accurate side-to-side layout is critical for successfully setting glass later on. The layout is determined by the width of the glass panels. Although most of the glass I use is custom-sized, it can be more economical to use standard sliding glass door replacement units. Regardless of the glass panel size, I plan for a 3/4-inch overlap at each side over the columns and cross purlins. With 3-inch glulams, this means that the on-center layout for each glass bay equals the glass unit width plus 1 1/2 inches.

Beams. On most small- and medium-sized rooms, the ledger and beams go up in one day. With the ledger in position and layout complete on the floor, I attach beam shoes to the slab or solid blocking in the floor with concrete anchors or lag screws. I have special 1/4-inch steel beam shoes made at a local metal shop with two holes — one for securing the shoe and the other for a

Figure 1. Steel beam shoes bolted to solid blocking and to the notched faces of the columns fix the sunroom frame to the deck.

lag screw to hold the column to the shoe. I rout a slot in the front face of the beam so the shoe sits flush with the beam (see Figure 1).

Sometimes, because of irregular slab heights, a column may need to be trimmed or shimmed up. Otherwise, each column-rafter pair is lagged together on site, then lifted into position and attached to both the ledger and a beam shoe (Figure 2).

After all the beams are in place, we carefully square them up and brace the entire frame.

At this point, I install the cross purlins along the front edge where the rafters and columns meet. A 1/4-inch mortise routed into the end of each rafter allows the purlins — which are ripped to match the roof pitch, and cut half an inch longer than the column and rafter spacing — to fit between the rafters, with their weight supported by the columns. I then toe-screw them in place with a pair of 4-inch #12 square-drive screws at each end, driven from the outside so they won't be visible.

For a neat, finished appearance, I use 3x4 glulam stock for the upper purlins, which fit between the rafters and are ripped to match the thickness of the finish ceiling. These are secured with a Simpson A-35 L-bracket at each end (Simpson Strong-Tie, 4637 Chabot St., Suite 200, Pleasanton, CA 94588; 800/999-5099; www.strongtie.com). The connectors are later concealed by the finished ceiling.

Roof & Walls

Because glass in a sunroom loses so much heat when the winter sun is not shining, the roof above should be well insulated. I install a 3/4-inch layer of extruded polystyrene under the 1/2-inch roof sheathing, so the total thickness matches that of the

Figure 2. After bolting the prefabricated ledger board to the house wall (top left), the crew erects glulam column and rafter units (top right). Custom beam hangers, attached to the rafter ends, drop into slots routed into the ledger (above), providing a strong, totally concealed connection.

Sunroom Details

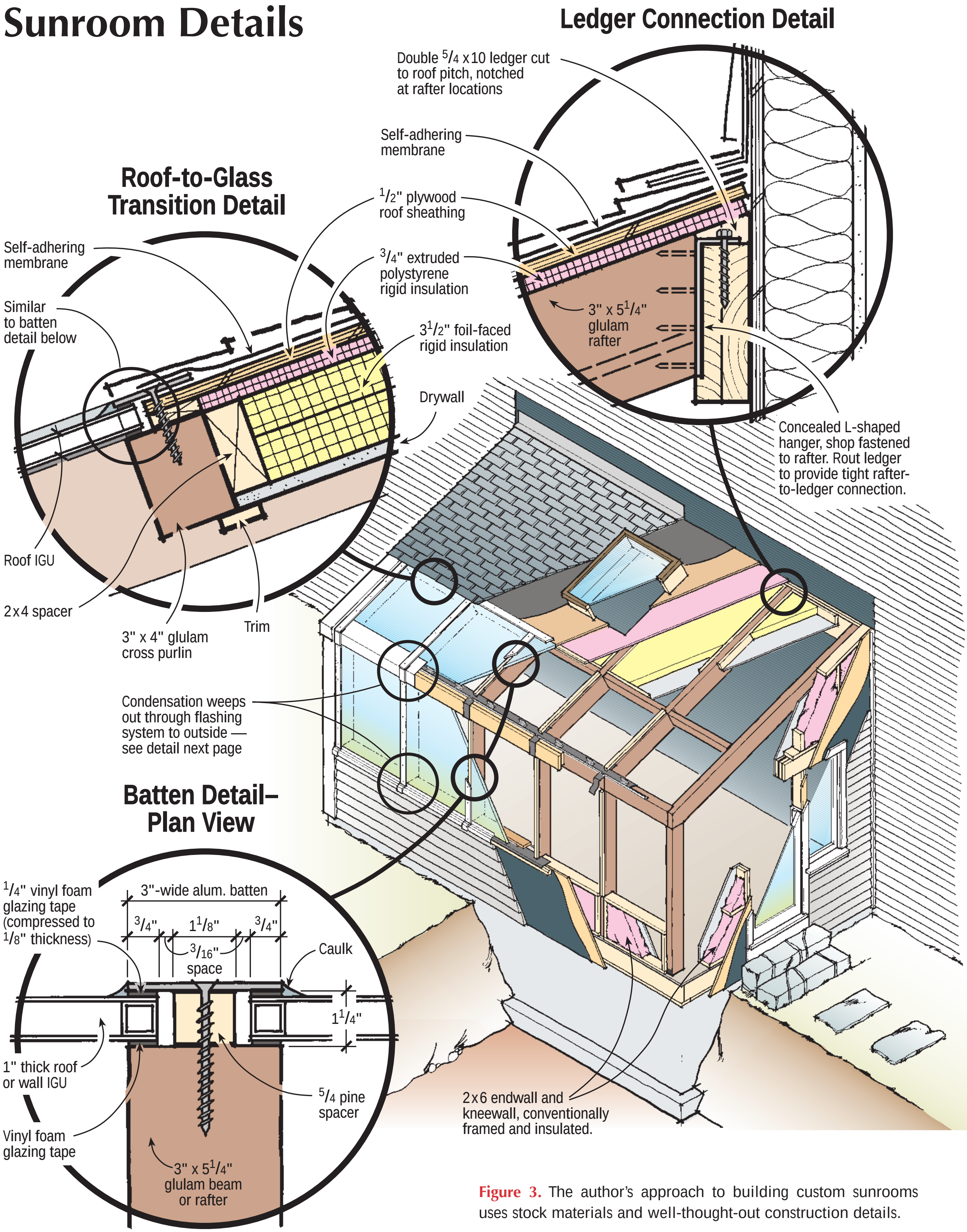

Figure 3. The author's approach to building custom sunrooms uses stock materials and well-thought-out construction details.

glass units and glazing tape (Figure 3). To beef up the roof's R-value, I later install drywall nailers in each bay and fill the cavity with 3 1/2 inches of foil-faced R-Max, by stacking layers of 2-inch and 1 1/2-inch material.

Endwalls. With the sunroom frame erected, I sheathe the roof and install any operative skylights. I extend the sheathing 6 inches beyond the edges of the outermost rafters to accommodate 2x6 endwalls. To prepare for framing these endwalls, I nail scrap 1/2-inch spacers, ripped from scrap 2-by stock, onto the end beams along the outermost edges. Later, after installing a 6-mil vapor barrier and butting the endwall framing up against these spacers, I'm able to slide drywall in behind the glulam beams. This makes for a very clean interior finish detail. Other than that, framing the endwalls on a shed roof sunroom is entirely conventional.

Kneewalls are framed between columns in each sunroom bay. While these are usually little more than insulation-filled cavities with the occasional electric wire, they can also accommodate awning windows that help with summertime ventilation. The height of the kneewalls is measured down from the cross purlins, and is determined by the height of the vertical glass, minus 1/2 inch to allow for the 3/4-inch overlap onto the top purlin and the 1/4-inch thickness of the rubber setting blocks.

After sheathing the kneewall, I nail an angled 1 1/2-inch blocking strip to its top edge, flush with the top plate (Figure 4). It's critical that the kneewall top plate, the sheathing, and the blocking strip — which support the bottom edges of the IGUs — provide a smooth and level surface. If a glazing unit is not supported evenly, its seal may break, causing it to fog.

Setting the Glass

With the kneewalls in place and the sunroom sheathed, it's time to prepare for setting the glass. The key element here is a custom condensation weep system that collects water from the interior glass surfaces, directs it to con-

Condensation Weep System

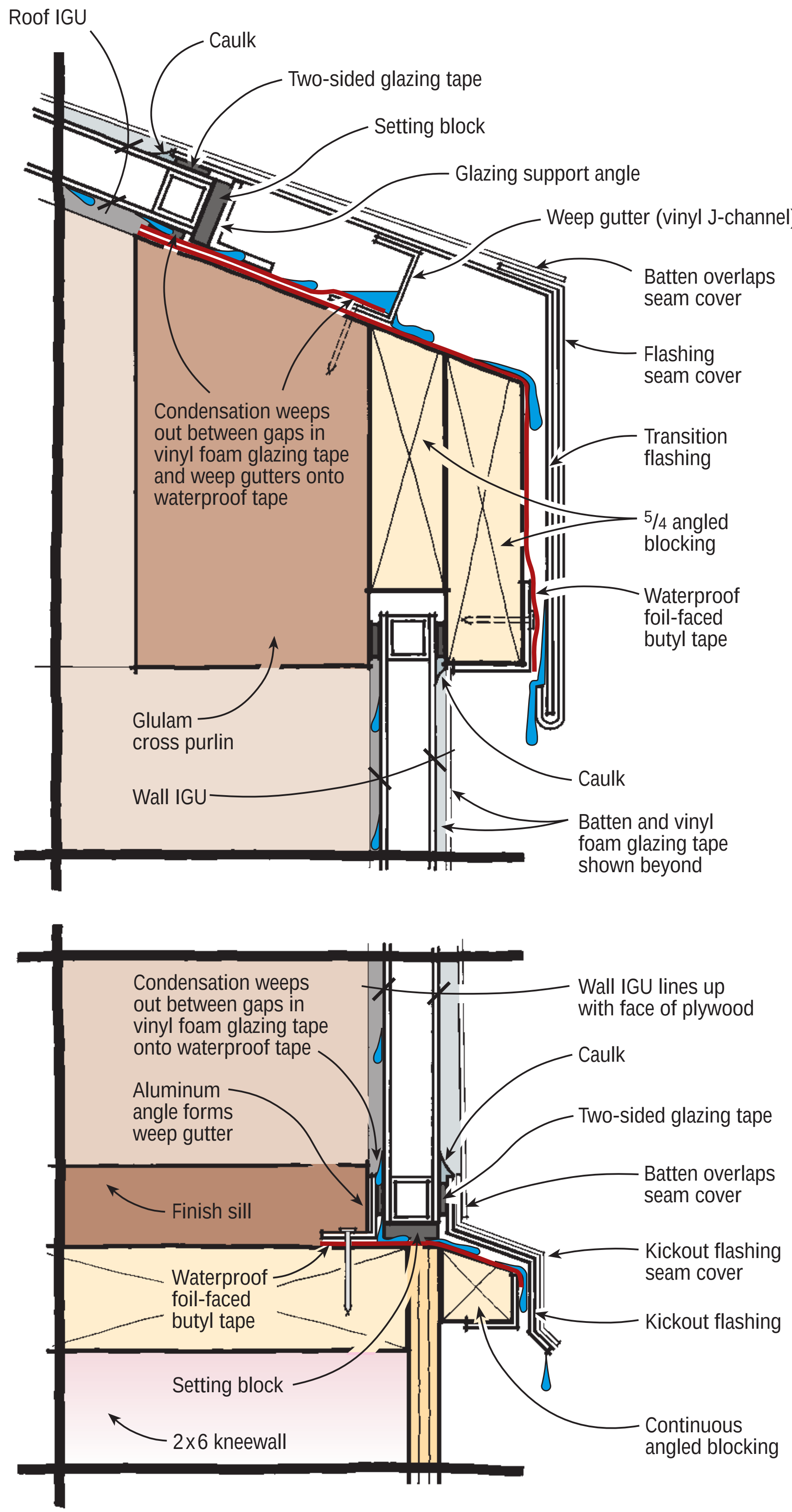

Figure 4. To prevent interior condensation from staining the glulam frame and eventually rotting it, a system of drainage openings and weep gutters directs moisture harmlessly to the outside.

Figure 5. Foil-faced butyl tape is applied to the kneewall top plate (above) and the eaves purlin (right) to shed condensation. Aluminum angle-glazing supports and vinyl weep gutters are also mounted on the eaves purlin.

Figure 6. A slight crown in the centers of the weep gutters on the eaves purlin prevents condensation from pooling within. The foil overlaps the lower lip of the weep gutter, acting as flashing to direct condensed moisture into gutters.

cealed drainage channels, and passes it harmlessly to the outside.

Weep gutters and foil. The first step in preparing for glass is to cover the tops of the kneewall plates and front purlins — the two main areas where condensation tends to pool — with a foil-faced, self-adhering waterproof tape (Foilastic tape, Tyco Adhesives, 1400 Providence Highway, Norwood, MA 02062; 800/248-7659; www.tycoadhesives.com).

Before the foil is applied to the front purlins, weep gutters are attached to their lower edges. Each gutter is actually a section of vinyl siding J-channel, cut 1/2 inch shorter than the center-to-center dimension between bays. The gutters are attached to the purlins with aluminum roofing nails, and the lower edge of the foil is tucked into the gutters, acting as flashing to control the flow of condensate (Figure 5). The collected moisture then trickles from the gaps between adjacent lengths of gutters, where additional 3-inch-wide tabs of foil direct it over the exterior blocking and onto the ground (Figure 6).

Glazing supports and spacers. Once I've installed the foil and weep gutters, I screw two short pieces of aluminum angle to each section of purlin, to support the bottom edge of the IGUs. Next, I fasten a wood spacer to the outer face of each column and rafter to form pockets for the glazing units. The spacers are 1 1/4-inch strips of 5/4 pine, turned on edge so they match the 1 1/4-inch combined thickness of the glass units and glazing tape. These are centered on the beam or rafter and secured with galvanized spiral nails, leaving about a 1-inch strip of beam exposed on each side.

Figure 7. Pine spacers nailed to beams define "pockets" sized for insulated glass units. Vinyl foam glazing-tape is applied to the glulam frame to act as a seal between the frame and IGUs.

Figure 8. Rubber glazing-blocks support vertical IGUs where they rest on the kneewall top plate. Wooden shims are useful for aligning blocks.

The exposed edges of these glazing pockets are lined with self-adhering strips of 1/4-inch vinyl foam glazing tape (C.R. Laurence, 2503 E. Vernon Ave., Los Angeles, CA 90058; 800/421-6144; www.crlaurence.com). The glazing tape acts as a gasket between the glass and the frame (Figure 7). I leave small gaps at the ends and center of the tape beneath the bottom edge of the roof glass. These small holes allow condensation to weep through the tape, and run down the foil that covers the purlins, into the weep gutters.

Setting the glass is just a matter of putting down rubber setting blocks, hoisting the IGUs, and easing them into position (Figure 8). A good vacuum cup designed for glazing makes this part a lot easier. We use one made by Woods Powr Grip (P.O. Box 368, Laurel, MT 59044; 800/548-7341; www.powrgrip.com). Occasionally, a piece of glass doesn't sit squarely in its bay, and when this happens, I use different-sized setting blocks to adjust its position. Wood scraps with protective glazing tape are used to hold glass units in position until the permanent battens can be installed.

Battens & Flashing

Once the vertical glass is in position, I run an additional strip of foam glazing tape along the outer top edge of each IGU, and screw two offset pieces of 5/4 pine blocking to the eaves purlin (Figure 9). This helps hold the glazing units in place, and creates an overhang to steer runoff and condensate away from the surface of the vertical glass.

Flashing the vertical glass. At the bottom of each vertical IGU, I install a strip of kickout flashing,

Figure 9. Angled blocking screwed to the eaves purlin secures the glass and directs condensation away from the vertical glass.

Figure 10. Stainless steel screws secure seam cover pieces that overlap adjoining sections of kickout flashing. Aluminum battens backed with glazing tape seal IGUs solidly to the glulam frame.

Figure 11. Two-sided sticky tape secures transition flashing to glass units at the eaves. Pressure from aluminum battens applied later will lock them solidly in place.

which I have made by a local sheet metal shop. The .040 aluminum comes prefinished, and has a protective plastic film that's removed on installation. As shown in the detail drawing, the kickout flashing is held clear of the foil-covered blocking beneath, leaving a continuous gap. This allows condensation that forms on the vertical glass to make its way under the setting blocks and trickle to the outside.

The kickout flashing is installed in sections, each of which is slightly shorter than the width of the glass, leaving the wood spacer-strips between the IGUs exposed. The flashing is simply stuck to the glass with a $^{1}/_{16}$ inch two-sided glazing tape, also manufactured by C.R. Laurence. Before sticking on the flashing, I clean both the glass and the flashing with isopropyl alcohol to ensure a good bond.

Once the main pieces of flashing are in position, I install separate cover pieces over the gaps between them. These seam cover pieces are 3-inch lengths of the same prebent aluminum stock. Each seam cover piece is centered over a wood spacer-strip so it overlaps the flashing on either side by $^{3}/_{4}$ inch, and is secured with a single stainless-steel panhead screw driven into the spacer.

Preparing and installing battens. I use 3x$^{3}/_{16}$-inch factory-finished aluminum bar stock for the permanent battens that secure the fixed glass units into position. I cut the battens to length back in the shop, and drill and countersink holes for the stainless steel screws I'll use to attach them. I also apply two strips of $^{1}/_{4}$-inch foam glazing tape to the back side of each batten, which seal it tightly to the glass. With the glazing tape preapplied, the battens can be taped into easily transportable bundles.

Installing the battens at the job site is a snap. I apply a doughnut of silicone caulk around the back of each screw hole to prevent leakage around the screws. I center a batten over each wood spacer-strip, with the bottom edge of the 3-inch batten overlapping the upper edge of the 3-inch seam cover flashing (Figure 10). I then screw them into place, wiping away any excess silicone that squeezes past the screwheads. When the battens are tightened down, the glazing tape should be slightly and evenly compressed along the entire run.

Flashing the roof glazing. The first portion of the roof glazing system to be installed is the endwall caps that cover the rake and corner boards, extending up under the roofing above the roof glass. Next, I install the transition flashing, which extends from the lower edge of the roof glazing, turns down at the eaves, and terminates in a drip-edge (Figure 11).

The transition flashing is formed from the same aluminum stock as the kickout flashing, and is installed in about the same way: Sections of flashing are attached to the glass with two-sided sticky tape (again, it's important to clean both surfaces with isopropyl alcohol first), and separate 3-inch seam cover pieces are lapped over the joints between them. The lower edges of the seam cover pieces are then crimped over the main transition flashing.

Once the transition flashing and seam covers are in place, I begin placing the battens, starting with the horizontal batten that runs along the upper edge of the glazing. The glazing units I work with are strong enough to walk on at this point, but I'm careful to avoid tracking sand or dirt onto the roof, which could scratch the glass. The battens over each rafter are butted against this upper horizontal batten, leaving a slight gap that can be sealed later with silicone caulk, and screwed in place. The lower ends of the roof battens extend to the outer corner of the transition flashing, overlapping the upper edges of the transition seam covers and clamping them firmly in place.

Caulking. After the flashing pieces and battens are in place, the glazing system must be carefully caulked along every edge where metal and glass meet. I use bronze-colored type 33 S silicone caulk from C.R. Laurence, which adheres well to both glass and aluminum. Again, I clean the surfaces with alcohol to ensure a good bond. The cleaned area must be completely dry before the caulk is applied. During cold weather, I use 90% alcohol to speed drying.

I caulk the perimeter of one IGU at a time, then go back and remove the excess silicone, using an empty plastic caulking cartridge with its applicator end cut off (Figure 12). I run the clean open end of the tube along the bead and scoop the excess into the tube, leaving a neat, attractive profile behind. Although this takes some practice, the results are worth it.

Figure 12. Silicone caulk provides a final seal against rain and meltwater. The author applies a liberal bead of caulk (top), before using an empty caulk tube to scoop up the excess and leave a uniform profile (above).

Figure 13. Lengths of aluminum angle, caulked to the kneewall sill, provide weep gutters that prevent condensation from pooling on the finished sill.

Figure 14. An interior view of the nearly finished sunroom. These IGUs are strong enough to walk on, but care is needed to prevent sand or grit from scratching the glass.

Finishing the Interior

I make the finished sills that sit over the kneewall top plates from $3/4 \times 5^1/4$ stock that I rip from glulam beam scraps and run through a portable planer. The resulting sills match the appearance of the adjacent beams, while the cross-sectional laminations provide an interesting "cutting board" effect.

Before the sills go on, though, I use small stainless steel nails to attach aluminum angle flashing to the rough sill, seating it in a bed of silicone caulk (Figure 13). Before the strip is nailed down, the surface that faces the glass receives a strip of foam glazing tape, with slight gaps at the ends and in the center. This creates a weep gutter to collect any condensation that runs down the vertical face of the glass. The water flows through the gaps in the glazing tape and under the glazing itself before dripping to the ground beneath the kickout flashing.

Glass options. I usually use tempered glass. For commercial jobs and residential roof glass higher than 10 feet above the floor, however, laminated safety glass is often required (Figure 14). Beyond safety issues, choosing the right insulated glass technology is complicated because of the numerous glass coatings and films that are available.

In northern New England where I work, low-e argon-filled glass units are my standard choice, although some of my customers elect to pay the premium for superinsulated units. Because so many different types of insulated glass units are available, it is important to choose the right glass for each situation and each geographical region (see "Choosing Energy-Efficient Windows,"1/99).

Dennis Bates, *owner of Vermont Sun Structures, has built more than 100 sunrooms across northern Vermont.*