Replacing a Full-Height Bay Window

A template simplifies the math for the hybrid frame

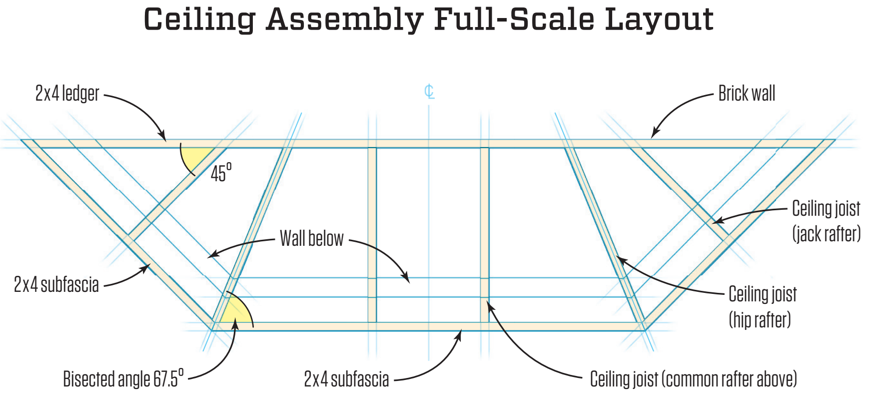
BY GREG BURNET

We were recently contracted to replace a "walk-into" bay window in a house built during the late 1970s. Unlike smaller bay windows that hang from a cable system or that are supported by brackets, these bays have floors that are either cantilevered or, as was the case in our project, supported by a full foundation.

The bay was quite large—about 9 feet wide and 7 feet tall without the roof—and a nearby privacy fence and mature landscaping would have made it almost impossible to bring in and install a stock unit without doing some damage. And although the existing bay window was likely a stock size back in its day, the closest available size we could find was about an inch too wide—close, but not ideal. Our solution—one that we've used in the past when remodeling bay windows—was to fabricate the components in our shop and then truck the bay window to the jobsite in manageable pieces for assembly there.

We began by measuring the existing bay and ordering three new windows. While we opted for Marvin Clad Ultimate Double Hung units for this project, almost any good-quality double-hung window would have worked. The windows themselves were stock, except for the code-required tempered glass for the lower glazing that would be just above the finished floor.

Photos: Sue Burnet



TEAROUT & TEMPLATING

After taking delivery of the windows, we turned to construction—or demolition, to be more precise. We tore down the existing bay, removing the windows, roofing, walls, and roof structure, and leaving only the floor and the sole plates in place **(1)**. The floor for this bay was structurally sound and the finish flooring was in good shape, so we protected it with a layer of Builder Board for the duration of the project.

Once we had finished the demolition, we made a template with a second piece of Builder Board, spreading the paper board over the floor in the opening and folding it to mark the location of the limestone sills **(2)**. We indexed the template by cutting in the corners of the house walls **(3)** and marked the outline of the plates by poking through the template with an awl **(4)**. Two poked holes along each wall served as dots we could connect to create a full-scale "plan" for accurately laying out and framing the roof and wall components. We also made a story pole marking the height and width of the opening **(5)**, and clearly labeled each critical reference on the story pole and the template. With the bay foundation and opening templated and measured, we tarped the opening and headed to the shop.

A DIFFERENT APPROACH TO FRAMING

The most challenging part of a bay window to frame is its faceted roof. My approach used to involve scaffolding and countless trips up and down ladders as I muddled through the cut-and-fit process. But then I realized that most bay roofs are small enough to frame on the ground and safely lift into place, saving time, sanity, and wear and tear on my knees. So now we fabricate the roof and other components in the shop, where my tools are all set up and we can contain most of the mess. We also don't have to worry about the weather.

For those of you looking for a lesson in classic roof framing, suspend your expectations for a moment. The strategy I use to build a bay-window roof bases all the framing on the template. The parts of the frame in one of my bay roofs are hybrid applications of familiar roof framing parts, but they work in the same way. I will explain the differences as I go along.

My strategy also allows me to modify the original roof if need be. For example, the demise of the windows in the existing bay was mostly due to the drip line of the roof not extending beyond the perimeter of the limestone sills below. Precipitation dripped off the roof onto the sills and splashed onto the windows, eventually caus-

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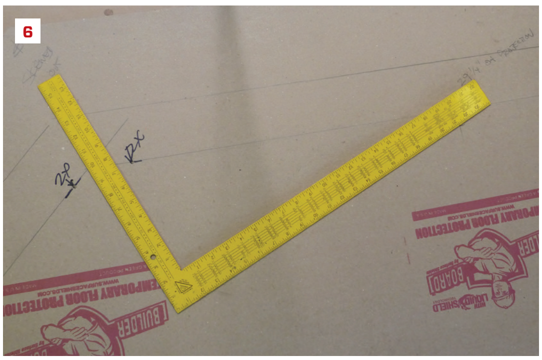

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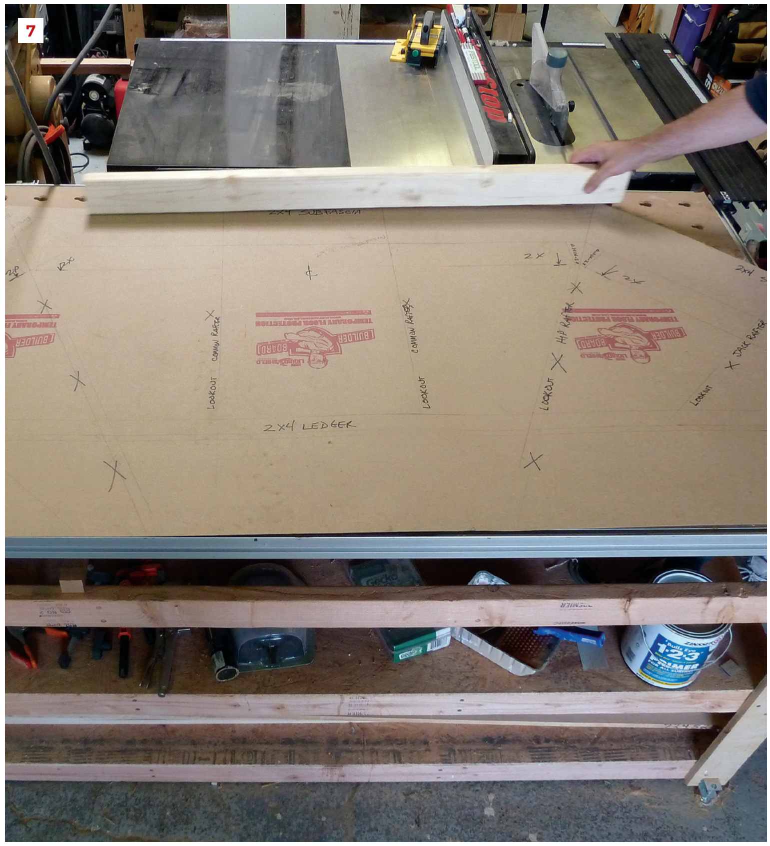


ing them to fail. When I made my template, I included the outer edge of the limestone sills. Then when I laid out the roof, I made sure that the drip line would fall outside of that perimeter.

The final advantages to this system are speed and efficiency. This strategy is a production approach to what can be a difficult framing challenge. Because all my figuring is based on the template, which is a full-scale plan of the frame, the complicated geometry is already done for me.

LAYOUT IN THE SHOP

At the shop, I unrolled the template and clamped it to a workbench. First I drew the walls on the template in plan view, connecting the holes I'd poked along the edge of the plate. I marked both the inside and outside edges of each wall. With my system, the ceiling joists and the rafters are in the same vertical plane, so the framing layout works for both (see Ceiling Assembly Full-Scale Layout, facing page). The ceiling joists extend beyond the wall plates for attaching the soffits.

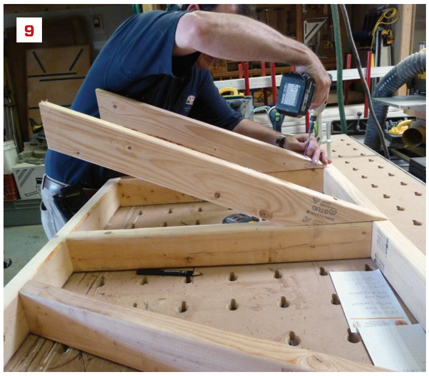
To lay out the angled joists (as well as the hips), I bisected the outside corners by placing a framing square on the line of the outside wall, set at a 5-in-12 pitch **(6)**, which happens to be 67.5 degrees and is the correct setting to bisect a 45-degree corner. I extended the lines to the back of the bay with a long straightedge held against the blade of the square. Accuracy of these lines is critical because the centerlines for the angled framing ultimately determine the intersection point of the hips, upper ledger, and side nailers **(7)**.

I drew a ledger that would span the entire width of the bay roof and attach to the brick wall. I also laid out the angled subfascia on the template. Normally there would be a common rafter right next to a hip rafter, but that would have given me three commons, so I drew in just two in conjunction with the ceiling joists below.

CEILING FIRST, THEN RAFTERS

With conventional roof framing, the walls are built first, then rafters with birdsmouths land on the wall plates to form the eaves overhang. With my method, the ceiling joists extend beyond the walls as lookouts to create the eaves. The rafters then get a simple seat cut and land on top of the lookouts.

I took measurements for the parts of the ceiling assembly directly from the template, and then I assembled the parts on top of the



template. Instead of nails, we used 3-inch construction-grade screws made by Grabber to fasten the framing together **(8)**. Screws help to keep the pieces on their layout marks during assembly, and they also fasten the components more securely than nails, which is a plus for transporting and lifting the roof into position.

With the ceiling assembly clamped to the bench, I turned to the common rafters. With conventional roof framing, the run of a common rafter is measured from the center of the ridge to the outside edge of the wall plate. But the run of these so-called commons was the distance from the outside edge of the ledger to the outside edge of the subfascia. So I calculated their length with a Construction Master calculator. I entered the roof pitch and the run (measured off the template). I hit the “Diag” button. The resulting dimension was the length of the rafters measured from long point to long point. We cut the two common rafters and screwed them to the joists, taking care to keep the rafters perfectly aligned with the joists **(9)**.

Next we measured between the centerlines of the two diagonal joists for the length of the “ridge,” which we cut and then screwed to the tops of the common rafters **(10)**. On a typical hip roof, the ridge sits behind the ends of the perpendicular walls. But on this roof, the ledger is outboard of that position, so the member above—while functioning as a ridge for attaching the rafters—really is just an upper ledger for attaching the roof to the wall.

CALCULATING THE TOUGH ANGLES

Once the ridge was in place, we found the length of the two nailers that would run from the ends of the ridge to the outside of the subfascia by simply measuring with a tape. But the pitch was different from the pitch of the commons, so we still needed to figure out the angle for the plumb cut and complementary seat cut. There are many ways to figure out these angles, including scribing, but I went back to the construction calculator because of its accuracy.

First I entered the run, taken from the template, and the rise, measured from the ceiling framing to the top of the ridge. I hit “‘Diag” to give me the length (which I’d already measured) and then hit “Pitch” once to give me the pitch in inches, and a second time to display the pitch in degrees. The angle of the plumb cut was 15.93 degrees, which I rounded to 16 degrees. For the heel cut, I used the complement of that angle: 74 degrees. We used a similar method to measure and fabricate the hip rafters. The plumb cut for the hip rafter also needed

to be cut with a bevel angle, which we took from the corresponding joist below.

I'd measured and cut the nailers to the long point of the subfascia, so the ends of the nailers stuck out beyond the edge of the subfascia, which put the edge of the nailers above the roof plane. We could have beveled the entire length of each nailer, but we decided to "drop" them instead to put the inside top edge in plane to catch the roof sheathing. To find the drop, we held the nailer in position on top of the joist, then struck a plumb line on its face where it overhung the framing below **(11)**. The height of the line (about $\frac{3}{8}$ inch in this case) equaled the amount of drop. I scribed this distance along the heel cut, then trimmed off that amount **(12)** so that we could install the nailers at the proper height **(13)**.

I call the last two rafters jack rafters, although technically they are probably hybrids. First we marked their location on the nailers with a framing square placed on the ledger **(14)**, and measured their length directly from the roof assembly **(15)**. We cut compound angles at the top ends of the jack rafters, with the plumb angle the same (5 in 12) as the commons, and the bevel angle at 45 degrees.

We also cut the roof sheathing sections while the bay roof was sitting on the bench **(16)**. We measured each section and transferred the dimensions to ½-inch CDX plywood. Because we would need to access the roof framing to secure it to the house, we just tacked the sheathing in place and then removed it **(17)**.

The last pieces made in the shop were the posts for the angled corners where the walls would meet at 45 degrees. We used our template to lay out the profile of the posts, transferring the dimensions to a section of 2x4. For each post, we ripped a bevel on one side of a pair of 2x4s **(18)**, then screwed the pair together on the bench to ensure a straight corner post **(19)**.

ASSEMBLING THE BAY ON SITE

The following day we returned to the site with all the parts for the bay. We cut two sets of plates: 1x4 bottom plates to set the windows at the correct height; and 2x4 top plates. We nailed the bottom plate to the existing sole plate and toe-nailed our angled corner posts to those plates **(20)**. Then we nailed the middle top plate to the tops of the posts to set the roof when we lifted it **(21)**.

The roof assembly weighed around 50 pounds, making it easy to lift and position on top of the front wall **(22)**. We supported the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inboard side of the roof temporarily with a 2x4 post. The corners of the top wall plate bisected the angled lookouts, so we positioned the wall, plumbed it, and secured it to the center ceiling joists **(23)**. We also secured the ridge, ledger, and side nailers to the masonry, using Tapcon screws driven through the framing. At this point, we filled in the top plates for the angled sides.

After reinstalling the roof sheathing we'd cut earlier, we put down a layer of Ice & Water Shield to dry in the roof structure, letting the membrane extend up the wall about three inches as an apron flashing. We nailed in miscellaneous blocking and sheathing to the wall framing and installed membrane sill pans in each window opening **(24)**. Next we set the windows, taking care to level and plumb them in the openings as well as in relation to each other **(25)**. After nailing them off, we taped the flanges with membrane flashing for a weatherproof installation.

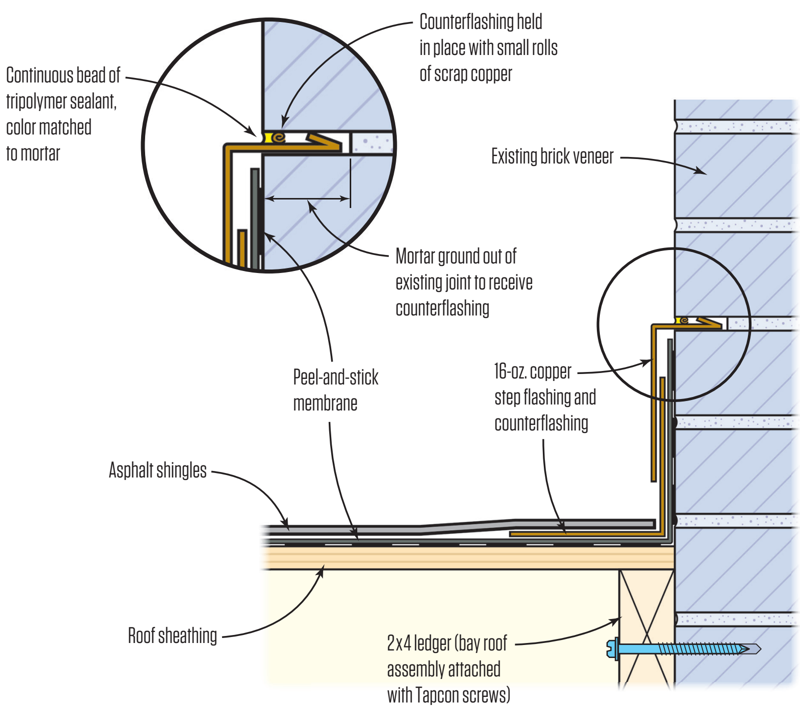
We trimmed the exterior of the bay with cellular PVC stock for durability and low maintenance, starting with the soffit and fascia **(26)**. We also trimmed the windows with flat PVC stock. Where the windows met the house, we tucked the trim into the air space between the masonry veneer and the sheathing of the house. This left the unfinished back edge of the brick veneer exposed, so to finish the side trim, we caulked in standard brick mold between the brick and the window trim.

FINISHING THE ROOF

With the trim done, we turned to the roofing. We made all the flashings out of copper on a sheet metal brake—including drip edge, step flashing, and counterflashing—to match the copper flashing on the rest of the house. We made all the flashing for the roof from half of a 3-foot by 10-foot sheet of 16-ounce copper, which we purchased from a local supplier. Because copper is fairly expensive, I laid out the components to minimize waste. I marked the copper with a Sharpie for the layout, and then made a nick with aviation snips at each mark that served as a registration when positioning the material in the brake.

Step flashing for a conventional roof is usually 5 by 7 inches before being formed. But the bay roof shingles met the wall at an angle and needed longer pieces of flashing. So I formed lengths of copper and cut four pieces of step flashing 10 inches long from each one.

Saw-Cut Reglet Flashing



I form step flashing with an angle that's slightly more than 90 degrees, so it springs in tightly between the roof and wall without interfering with the counterflashing. We also fabricated our own drip edge, customized to the project dimensions and to the correct roof pitch. To prevent galvanic reaction, we used copper roofing nails to fasten the drip edge and step flashing to the roof deck **(27)**.

We installed roof shingles that matched those on the house and added counterflashing to cover the step flashing and the apron (see Saw-Cut Reglet Flashing illustration, above). In a perfect world, the counterflashing would go through the masonry veneer and under the WRB on the sheathing, but that would have meant tearing out and rebuilding the veneer (which was not in the budget). Instead, I let the flashing into the mortar joints two courses of brick above the roof in a stair-step pattern. I ground the mortar out of the joints to a depth of about one inch, using a mini-grinder fitted with a diamond blade. Then I laid out and sheared each piece, using a sheet-metal folding tool to bend the top leg 90 degrees to the body.

Starting at the low end of the roof, we installed the counterflashing by inserting the leg into the mortar joint. To hold the counterflashing in place, we made small rolls of scrap copper that we pushed into the mortar joints above the flashing. These "jelly rolls," as they're sometimes called, have enough spring in them to wedge the flashing in place. We make sure that these rolls are pushed in past the face of the brick so that they don't interfere with the bead of sealant that finishes the joint. Progressing up the roof, each piece of counterflashing overlaps the one below it by a couple of inches.

To ensure a clean bond between the sealant and the masonry, I had rinsed the brick after grinding to remove dust and debris. After the brick had thoroughly dried, I applied a tripolymer sealant in a color that matched the mortar into each horizontal joint, sealing the flashing to the masonry. Vertical flashing joints were not sealed, to let any moisture behind the flashing escape.

The client insulated and finished the inside of the bay as part of an ongoing remodel. The bay took about three man-days to complete—longer than it takes to install most pre-manufactured units—but in the end the custom-fit bay was well worth the effort.

Veteran JLC Live Presenter Greg Burnet runs Chicago Window and Door Solutions, a carpentry contracting company in Chicago.