

## Rafter Framing for a Conical Roof

BY NATHANIEL ELDON

**Last year, I completed a project** that incorporated a half-round turret-like porch. In the article “Framing a Two-Story Half Round Porch” (Apr/19), I discussed the curved framing—mainly the semicircular steel assembly and integrating it with the wood-frame house—but I stopped short of discussing the semicircular conical roof that capped off the porch.

**Hip beginnings.** The roof rafters for the half-cone rested on a curved 2-by plate that we attached to the uppermost curved steel beam with powder-actuated fasteners and 1/2-inch-diameter carriage bolts. The conical roof was actually the end of a gabled roof volume that extended from the house out over the porch. We started by cutting the common rafters for the gable roof. The rafters for the conical section would have the same tail details as the commons, but the top cuts (for the point of the cone) would have to be measured and cut later, so we set the pattern rafter aside.

We ran a 2x10 ridge from the house over to where the semicircular framing of the porch began. In hip-roof fashion, we installed

three king commons. The first ran in a straight line from the end of the ridge to the midpoint of the curved plate (1). The next two king commons opposed each other at the end of the ridge (2). These two rafters were perpendicular to the ridge and ran down to the beginning of the semicircle on either side.

**A tight intersection.** With a hip roof, a hip rafter would extend 45 degrees out from the king-common intersection to the corner of the building. Because there was no corner, the rafters for this roof simply fanned out around the semicircle. I was concerned about the intersection where seventeen 2x8 rafters were all supposed to meet. I considered installing headers to catch some of the intermediate rafters, but a header would be a straight line between the radial rafters, with the top edge below the curved plane of the roof. In situations such as this, I find that the best strategy is making a full-size plan drawing of the roof to visualize the framing.

**Full-scale drawing.** With the house still in its early framing stages, we picked out a large open floor area for the drawing. After



Like framing a hip roof, framing a cone begins with three common rafters. The first comes off the end of the ridge (1), and the other two support the ridge from the sides (2).



A full-scale drawing allowed the crew to visualize the intersection of the radial rafters. After swinging a semicircle to represent the top plate (3), they used a ripping to trace the rafters one by one (4). Darkening the lines let them see the end cut details (5).



The crew found the midpoint of a 2-by spanning between the common rafters and transferred that point to the plate to mark the positions of the “eighth” rafters (6). Midway between those points and the common rafters (7), they marked the positions of the “sixteenth” rafters (8). After laying out the rafters, the crew measured from the plate to the shoulder of the angled cut to find the length of each rafter (9).



The rafter tails were identical to the commons, so the crew used the pattern rafter to trace the tail, and then cut the details (10). After measuring and marking the shoulders of the plumb cut, they took the saw angle from the floor drawing and cut the top (11).

picking a center point for the semicircle (the center point of the end of the ridge), we drew its outer circumference (3) and snapped centerlines for the three king common rafters. Using a straight ripping of 2-by material, we drew the outlines of the kings (4), which divided the half circle into two quarters of a circle. Next, we found the center point between the kings and drew in the rafters that broke the semicircle into eighths of a circle, then sixteenths, and finally thirty-seconds. That layout put the rafter tails just under 16 inches apart.

So far, we'd let all the lines intersect at the top, but now I darkened in the ends of the rafters starting with the kings (5). The “eighth”

rafters were followed by the “sixteenth” rafters. The acute angle at the end of the “sixteenth” rafters would be greater than 45 degrees, but we could still cut it with a circular saw. I decided just to butt the “thirty-second” rafters into the available spaces rather than trying to cut long tapered ends. Darkening in the ends of the rafters at the intersection also allowed us to take the cut angles directly from the full-scale drawing.

**Plate layout.** The tail ends of all the rafters in the semicircle would be identical, but before cutting, we needed to lay out the rafter positions on the plate. Typically, rafter layout on a straight plate





The arcs between the king commons were each a fourth of a circle's circumference. The first two rafters installed split those arcs into eighths (12). Starting at one end of the semicircle, the crew then installed the four rafters that created sixteenths along with the eight "thirty-second" rafters (13, 14). They nailed the rafters together at the peak (15) and tapped down any uneven ones (16).

means pulling a tape down the length, marking the rafter positions, and squaring the marks by holding the edge of the square against the plate. But with the curved plate, we couldn't just "pull" the layout, and we couldn't hold a square to the edge of the plate to mark the positions. Instead, we kept dividing the space between the king commons in half until we got the layout we needed.

We cut a 2-by to exactly span the quarter circle between the king commons, marked the midpoint on the 2-by, and squared over from that point onto the plate for the "eighth" rafters (6). After laying out their positions, we measured between that layout and the king common (7) and transferred the measurement to the 2-by. Then we used the 2-by to measure and mark the positions of "sixteenth" rafters (8). Those rafters were close enough together that we just measured to the midpoint for the position of the "thirty-second" rafters.

**Rafters in the round.** With the plates laid out, it was time to cut and fit the rafters. We measured from the outside edge of the plate to the shoulder position of the "eighth" rafters (9). We laid out and cut the rafter tails using the pattern rafter set aside earlier to mark

the eaves overhang and the birdsmouth (10). Then we measured up for the plumb cut. Taking the angle from the floor layout, we set the saw blade angle and made the plumb cut at the top ends of the rafters (11).

After cutting and installing the "eighth" rafters (12), we turned to the "sixteenth" rafters. We measured and cut them in the same fashion (13), but this time the acute angle made the cut a bit more challenging.

Instead of installing all of the "sixteenth" rafters, we started at one side of the semicircle, installing the "sixteenth" rafters and filling in the "thirty-second" rafters while we were still in position (14).

To join the rafters at the top of the cone, we toenailed or face-nailed wherever possible (15). When all the radial rafters were installed, I went around and made sure they were all in plane for the sheathing and trim, tapping them down where necessary (16).

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