Designing a Cone Roof

by Libby Maurer

Careful thought and a little creativity go a long way in a "first time" design.

at a glance

- Andrews Truss designed and built the trusses for a cone-shaped tower measuring 75' tall and 21' across.
- The tower was part of a 4,000 sq. ft. vacation home in northwestern North Carolina located near the "Tail of the Dragon" highway.
- This was technician Phil Close's first experience designing trusses for a tower this shape.
- The key, he said, was a lot of careful thought before beginning the design.

The trusses for the roof system shown here were designed and built at Andrews Truss, Inc. in North Carolina. Though the company is well known for designing unique roof and floor systems for custom homes, this was the first time the company was asked to design a "cone" roof system, according to senior technician Phil Close.

The trusses were designed for a round tower measuring roughly 75' tall and 21' across. Close began by inputting the walls in a radius in four sections of 32 pieces, totaling 128 sections. "We wanted that many sections to get as close to radius as possible," he said, noting that the more sections that are made, the more of a true, round shape you get. Close said although it pays to be exact when designing a structure this complex, creating the initial radius was a tedious process.

He then added planes on each of the 128 sections to create the cone shape, at a 12/12 pitch and a 14-1/2" cantilevered overhang. Close said one feature of the software Andrews uses "auto-solved" all the planes in the cone. With the exact cone dimensions defined, Close was ready to tackle the design of the structural elements of the roof frame.

"I knew the only way to proceed would be to construct a frame within the cone," he said. So Close free-handed an actual grid marking straight lines—both horizontal and vertically—through the cone. This design served as the basis for a simple girder frame that he then created an electronic drawing for.

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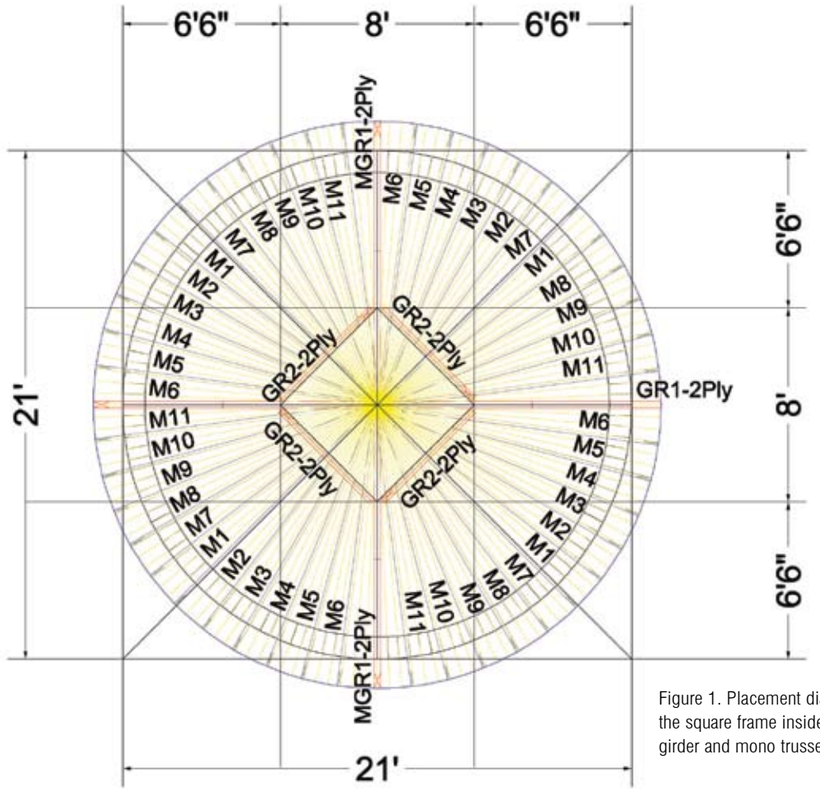

Figure 1. Placement diagram showing the square frame inside the cone, girder and mono trusses.

View of the framed tower from the inside.

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The frame formed a perfect 8' square, which Close then crisscrossed with two intersecting lines, dividing the cone area into four equal quarters (see photo on facing page). To form the "X," one 2-ply girder spanned from one wall of the cone to the other (GR1), and two 2-ply mono trusses (each MGR1 trusses were half the length of the long girder) tied into the square frame, intersecting GR1. He then designed the elements of the 8' square, which was constructed with four 2-ply girder trusses with flat top chords to be hung 4' from the center of the square (GR2). All of the GR1, GR2 and MGR1 trusses were designed to be 6' with a flat top chord. (See Figure 1 on page 25.)

Next, eleven different types of top chord bearing mono trusses were designed in all of the four sections, each spaced at 16-1/2" on center at the exterior wall. Close designed the total of 44 monos to sit on one of the trusses that make up the girder frame (GR2). Half of the mono trusses had top chords that would extend up to the tip of the cone from the GR2 trusses. This was done, Close said, to give the framer a way to create the desired "cone peak" look.

Located in the remote western part of North Carolina, Andrews is perfectly situated to serve the vacation and custom home market in local resort areas like the Smoky Mountains to the north. The roughly 4,000 sq. ft. vacation home is set on the side of a mountain overlooking Lake Santeetlah (see photo above). Close said it is near the start of the "Tail of the Dragon" highway, a road well-known by motorcycle riders and other thrill enthusiasts. The highway boasts 16 miles and 318 turns!

For any other component manufacturer, the road's rugged characteristics would present an interesting challenge. But Andrews' truck drivers were well-equipped to navigate the twists and turns. "Since we're in the mountains of North Carolina, there are some places we just couldn't get to without customizing our trucks and trailers," said Close. "So we have all sorts of wild things here."

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View of Lake Santeetlah from inside the tower.

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Prior to erecting the trusses, Close sat down with the framer to discuss how the mono trusses should be set. "It only took about ten minutes," he said. Because the jobsite was on a steep mountain, it was necessary to frame as much of the system as possible on level ground. So Close arranged for the girder system to be assembled on the home's deck, and then the system was lifted into place by crane. The crane was fitted with a bucket attachment which raised the pieces up to the tower while a framing crew secured them from inside the upper room. The 44 mono trusses were set one quarter at a time, starting with M1 in one quarter and proceeding with M2 through M11 in the same quarter. The process was repeated in each of the other three quarters, again using the bucket to lift the monos to the tower. The framer used the same bucket system to sheath the outside of the cone.

The key to dealing with the pressure of carrying out a complex design scenario for the first time and getting it to fit together perfectly on site is, simply enough, "a lot of thought," said Close. Thinking through each of the challenges with logic and an eye toward creativity was well worth it. "I was at the site after the cone was set and everyone from the builder to the homeowner was thrilled with the results," he said. **SBC**

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Truss Publications, Inc.

6300 Enterprise Lane • Suite 200 • Madison, WI 53719
608/310-6706 phone • 608/271-7006 fax
www.sbcmag.info • admgr@sbcmag.info