Church Add-On Gets Beautiful New Chapel with Components

by Joe Heinsman, P.E.

The design of a new chapel showcases innovative use of components.

at a glance

- Stock Building Supply helped to design and build a showy chapel addition.
- The use of components became interesting when the structural engineer decided that the significant horizontal deflection inherent in steep pitched scissors trusses would be greater than what would be acceptable for this structure.
- The height of the trusses required that they be built in halves and field assembled.

An addition onto the Toney Chapel to Southport Presbyterian Church in Southport, IN was a unique use of trusses with a number of interesting structural features. While simple in concept and plan, the number of creative approaches needed to construct this "simple" building presented some interesting challenges. The trusses were designed and supplied by Stock Building Supply in Franklin, IN (Davidson Lumber Co. at the time of construction).

The basic plan of the chapel is a cross shape with each of the legs being 40' wide. The legs are relatively short compared to their width. The two side legs are 14'-8" long and the front and back legs are about half of that. There is a gable at the end of each leg. Four intersecting vaults meeting at a point at the center of the building with a high ceiling pitch that was designed for aesthetic effect. The roof was designed at a 12/12 pitch and the ceiling an 8/12 pitch. The walls were designed to be 14' tall.

The use of structural components became interesting when the structural engineer, Scott Jones of Arsee Engineers, decided that the significant horizontal deflection inherent in the 40' steep pitched scissors trusses would be greater than what would be acceptable for this structure. In addition, the height of the trusses required that they be built in halves and field assembled. His solution was to have the scissors trusses designed similar to three hinged arches and design the exterior walls to

Continued on page 26

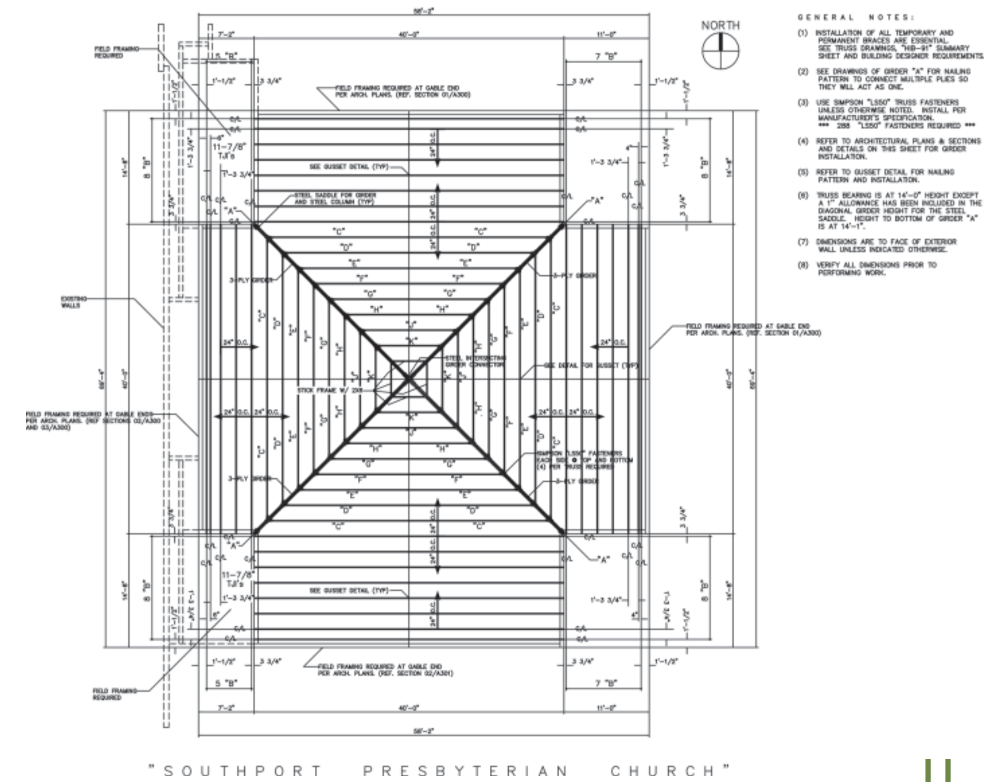

Figure 1. The design drawing indicates four intersecting vaults meeting at a point at the center of the building with a high ceiling pitch. The roof was designed at a 12/12 pitch and the ceiling an 8/12 pitch.

Photo 1. After the steep half scissors trusses were assembled on the jobsite, the trusses for each of the four legs of the addition were set by crane. Steel beams along the top of the walls of each leg and glulam beams in each of the four gables resist horizontal and vertical forces.

Photo 2. For aesthetic purposes, the glulam beams are all exposed on the inside of the finished structure

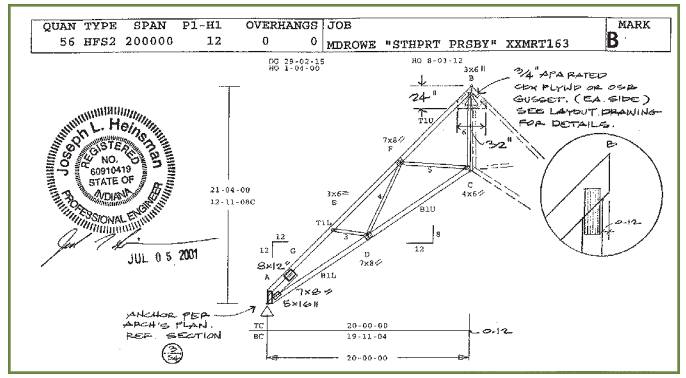

Figure 2.

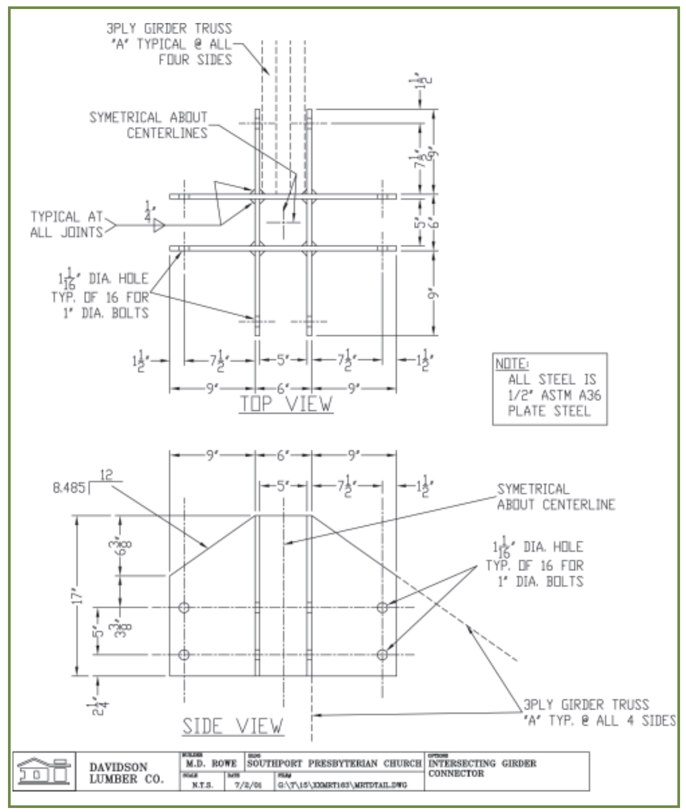

Figure 3.

Church Add-on...

Continued from page 24

resist the horizontal thrust that resulted. A combination of steel in the side walls of each leg of the chapel and glulam beams in the gables was used to resist the horizontal forces. The steel in the side walls was a wide flange beam along the top of the wall to carry the vertical load with a flat–side-up C-channel on top of it to resist the horizontal thrust of the trusses. Horizontal steel saddles with bolt holes were welded to the top of the C-channel at each truss location. At the inside corners the horizontal load was transferred into the intersecting perpendicular wall's steel framing where it was resisted by either an angled tube steel brace within that wall or steel truss frames that were used in the two walls with openings in them that were too close to the corners to allow the use of the angled braces. At the gable ends, to resist the outward horizontal thrust of the trusses, a horizontal glulam beam ran across the gable end at the top of the walls tying the ends of the walls on either side of the gable together. This glulam was interrupted by two vertical glulam columns. Continuity of the horizontal glulam was achieved by attaching steel brackets to the vertical columns and horizontal glulam at their intersections. These beams, both horizontal and vertical, also served to create a frame to support the large gable wall framing. For aesthetic purposes, the glulam beams are all exposed on the inside of the finished structure (see Photo 2 above).

The trusses were designed and built as half scissors trusses leaning on each other with the only connection at the peak between the top chords using a plywood gusset and nails (see Figure 2). A light connection was made between the bottom chords for stability during erection. Four 3-ply half scissors girder trusses starting from the four inside corners extended to the center point of the building and were also designed similar to 3-hinged arches. These girder trusses leaned against a center compression ring at their peak which was designed and supplied by Stock Building Supply (see Figure 3). The compression ring was of ½" plate steel with flange extending down each side of each of the four girders. Two 1" diameter thru-bolts were used at each girder truss. Again the connection was at the top chord only. Stubbed trusses ran

Continued on page 28

Church Add-on...

Continued from page 26

between the girder trusses progressing toward the center of the building. Only the shorter of these were not also hinged at their peak. All webs in the trusses had to be aligned because of the need to pass a number of large ducts through the trusses and spread them out throughout the four legs of the building. Since all the trusses were the same basic profile, a stub of that basic profile, or as in the case of the girders—an elongated version of that basic profile, the task of aligning the webs was easily accomplished. The panel nearest the peak was the largest opening and was where all the ductwork was located. The area nearest the center of the roof was stick framed between the girders because the end verticals of stubbed trusses in this area would have interfered with the passage of the ducts. The large horizontal reaction of the girder trusses combined with the horizontal load that was brought to the inside corners by the steel C-channels on top of the walls resulted in a very large overturning load at these corners. As a result, the vertical steel columns that the girders rest on are in tension and a large concrete footing was needed at the base of the column to create the dead weight necessary to hold the column down.

After discussing various options with the project engineer, the decision was made to avoid expensive special order connectors to attach the stubbed trusses to the girders. Instead, the trusses were supported on a sloping 2x6 ledger nailed to the 2x12 top chord of the girders and dropped far enough to allow for a top chord bearing detail. This resulted in double miter cuts on the ends of the top chords with one miter cut against the face of the girder and one miter cut against the top of the ledger. The bottom chords were also mitered against the face of the girder truss (see Figure 4). To keep the trusses from sliding down the ledger, mitered blocking was added between the trusses. The blocking was nailed to the girders with a thru bolt added to keep it from being pried off the face of the girder by the truss it held in place. A standard framing connector was also used from the top of the girder to the top chord of each stubbed truss to keep the truss from sliding away from the girder and off the ledger (see Figure 5). All of this required careful coordination between Stock Building Supply and the project engineer.

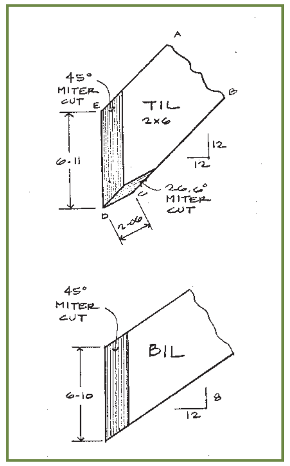

Figure 4.

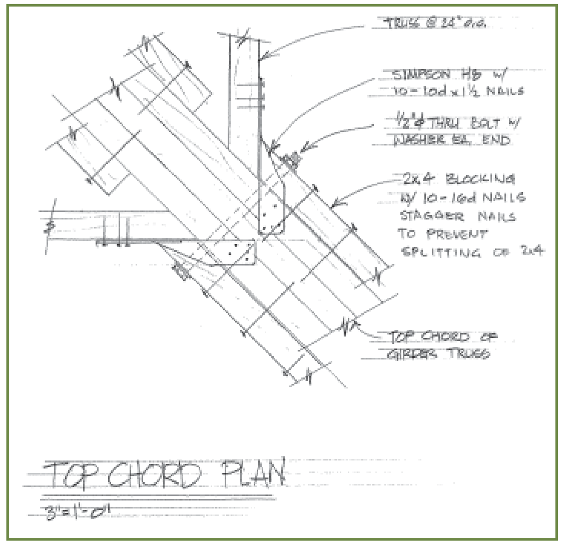

Figure 5. Detail courtesy of Scott Jones, Arsee Engineers, Inc.

The end result was a beautiful chapel which the parishioners of Southport Presbyterian Church have been able to enjoy since it was completed in 2002. According to Dan Plummer, Director of Environmental Services with Southport Presbyterian Church, they have had no problem at all with drywall cracking or any other movement-related problems. SBC

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