Practical Solutions

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Long-Span CFS Trusses Reach New Heights

By Mike Pellock, P.E. and David Boyd

When starting something new, it is a good idea to start small, work out the kinks and make the inevitable mistakes on a small scale before expanding a product or a process. Businesses do not start off as Fortune 100 companies. Musicians do not purchase Stradivarius violins or P. Mauriat saxophones before they spend hours of practice honing their skill. Churches begin meeting in school gymnasiums before breaking ground on their first small building, with hopes to expand as their memberships grow.

Such has been the case with cold-formed steel trusses. When steel trusses were first introduced as a framing option for commercial and institutional projects, they were used in areas of relatively short spans. For example, small mansard trusses on a store front or a small office building with sloped roofs. These trusses paved the way for larger and more complex roof shapes. Today, it is safe to say that the cold-formed steel truss industry has advanced to the point where architects are taking advantage of the strength capabilities and design flexibility of CFS trusses to regularly stretch the envelope with longer clear spans, complex intersecting roof planes and girders supporting large roof areas.

One example of starting small and growing is the First Baptist Church of Lake St. Louis (FBCLSL). From the small original chapel to the current expansion of the sanctuary and office, this church building has seen many changes over the last several decades. Moreover, in 2013, they were ready to expand again.

As with any successful construction project, there must be a vision from the owner, combined with the construction expertise of the building designers to bring that vision to life. LePique & Orne Architects, Inc. has worked with FBCLSL several times during previous projects and understood the goals. According to Dennis Elledge (architect), "Based on the client's requirements and to more fully integrate the building facade design into the primarily residential community of Lake St. Louis, we were led to the use of sloped and shingled roof construction. With this sloped roof direction in mind, the use of pre-engineered trusses seemed to be the right fit. After considering the various pros and cons of wood trusses versus steel trusses, we concluded that steel trusses were the correct solution, especially regarding longevity, strength and deflection requirements." Ædifica Case Engineering had worked with cold-formed steel trusses in the past and agreed that the strength, as well as the design versatility, would be the best fit for the long spans of almost 80 feet (*Figure 1*).

Throughout the design phase, several critical discussions were required so that all systems involved would work in conjunction with the new roof structure. The open dialogue between the architect, structural engineer, and cold-formed steel truss designer was instrumental in assuring that all systems went together well. Stephen Sacco, P.E., structural engineer and principal at Ædifica Case stated, "During the design phase, our structural engineers needed to take into account the additional horizontal deflection due to live loading (snow, etc.), and take this lateral movement into account when reviewing outward movement of exterior bearing walls and detailing the interior drywall joints at the wall/ceiling interface. An Aegis representative ran various load conditions for dead and live loads at our request to get a range of deflections we would need in design and detailing, so we could consult with and advise the architect and owner." For Elledge, his focus was on the goal of the client. "The new and larger sanctuary required open and vaulted space to accommodate state-of-the-art audiovisual elements as well as the impressive and open worship environment they desired. The unobstructed sanctuary space was accomplished with the use of CFS scissors trusses."

Figure 1.

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Figure 2. Example use of spreader bar.

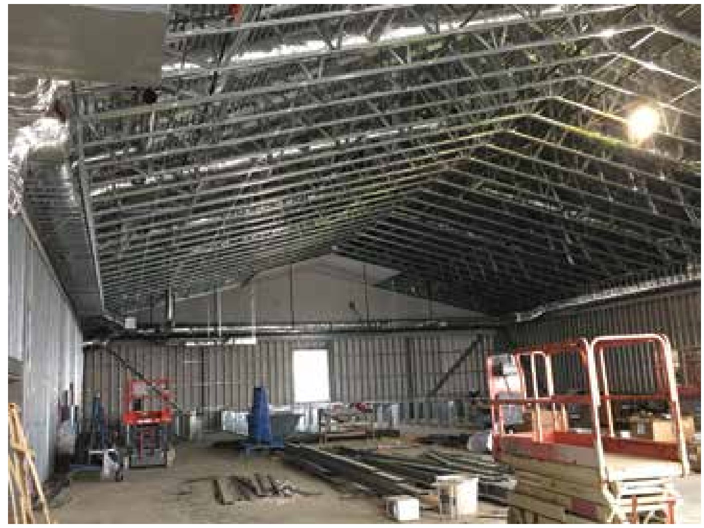

Figure 3.

As if 78-foot scissors trusses were not enough of a challenge, the church expansion faced delays due to a significant rainy season, substandard soil properties as well as an increase in the project scope half way through the project. The timeline for design, manufacture, and delivery of the trusses was squeezed significantly to minimize any delays in the construction schedule. To meet the new time restraints, the design expertise of the specialty truss engineer, Aegis Metal Framing, and the extensive truss experience of the truss fabricator, Engineered Steel Products, were put to the test. With 441 individual trusses to build and 153 unique truss profiles to design to form this roof, it was critical that all parts of the roof system fit together, with all trusses and connections properly designed and installed, to create the desired architectural look that blended in with the neighborhood. The variety of truss shapes and connections, along with the long-span scissors trusses, created the potential for a challenging installation for the truss installer, Bender Construction. However, using the appropriate spreader bar for the long trusses, the crew set 19 of the 78-foot scissors trusses in one 8-hour shift (*Figure 2*), which was quite an accomplishment. Installation included all required lateral and diagonal restraint bracing for the webs and chord members. As trusses were erected, hat channel was installed for bracing using self-drilling screws as required per the plan. Although the installation crew was a little timid when setting the first of those large clear span truss, after getting a few set and braced, they found their rhythm and made quick work of the 24,700 square foot of roof area. Adding to the efficiency of the installation was the fact that the truss-to-truss and truss-to-bearing connections were simple to install. Connection to the supporting walls was made with standard Aegis HD clips with self-drilling screws into the trusses and supporting walls. Truss to truss connections were aided by factory installed skewable connectors on the tie-in trusses and receiving girder plates on the girder trusses (*Figure 3*).

As illustrated by the FBCLSL project, long clear-span CFS truss projects can present a variety of challenges to consider during the roof layout and design phase of the project. One such challenge results from the combination of slope and span of the truss that creates a truss profile that is too tall to ship from the manufacturing plant to the job site. One common solution is to design the truss in multiple pieces: a base truss designed with a height feasible for shipping (10-12 feet) and a cap truss, sometimes called piggyback truss, designed to be installed on top of the base trusses to finish the slope. In this application, it is critical that lateral and diagonal bracing is installed along the flat portion of the top chord of the base truss to ensure stability before installing the cap trusses, and to provide permanent lateral bracing/restraint of the unsheathed flat portion of the base truss. The Building Code, by reference to the *Code of Standard Practice for Cold-Formed Steel Structural Framing*, AISI S202, provides for three options for truss member restraint/bracing: Standard Industry Details, Substitution with Reinforcement, or Project Specific Design. The specialty truss engineer is an excellent resource for specifying and designing member lateral and diagonal restraint/bracing for the roof system. They are generally more informed regarding requirements, limitations and general understanding of the CFS roof system than the EOR or building designer. Handling, storage, delivery and installation are critical processes for all CFS trusses and require careful and thorough attention. With long-span CFS trusses, the importance is magnified. Particular care must be taken to ensure trusses are not damaged and are installed properly, with all required connections and bracing, so they function as designed. *The Cold-Formed Steel Building Component Safety Information* (CFSBCSI), published by The Cold-Formed Steel Council of the Structural Building Components Association, is one reference for standard industry details as well as information covering truss handling, storage, and installation.

There are many different types of buildings that can take advantage of the long-span capabilities of cold-formed steel trusses. Church sanctuaries with an open cathedral ceiling are one excellent example. Fire stations with open mechanical bays are another. As Stephen Sacco closed out his discussion of the expansion of the First Baptist Church of Lake St Louis, his words fit well for other projects. "In the end, long-span, cold-formed steel roof trusses proved to be the correct and obvious choice for this high-profile project."▪

FBCLSL Project Team

Owner: First Baptist Church, Lake St. Louis, MO

Structural Engineer: Ædifica Case Engineering, Fenton, MO

Architect: LePique & Orne Architects, Inc., St. Charles, MO

Truss Engineer: Aegis Metal Framing, Chesterfield, MO

Truss Fabricator: Engineered Steel Products, Wright City, MO

General Contractor: Demien Construction, Wentzville, MO

Truss Installer: Bender Construction, St. Louis, MO