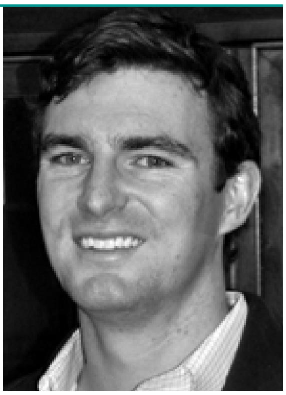
conference preview

WORKING WITH LARGE TRUSSES

What to keep in mind from design to erection.

BY SYLVIE BOULANGER, P.ENG., PH.D., AND COLLIN HUGHES

Installation of a two-story-tall transfer truss at the ground level of a 50-story office building; the truss transfers the loads of two 48-story-tall columns.



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LARGE STEEL TRUSSES are continually being pushed to span further, support larger loads and be more aesthetically appealing.

The challenge is to develop efficient, cost-effective and eye-catching designs through a collaborative effort between engineers, fabricators and erectors. To meet that challenge, four key factors need to be addressed:

- Selection and location of splices
- Method of camber
- Selection and orientation of members
- Special assembly requirements from shop to site

Splices. Some of the most critical items to collaborate on when working with large trusses are splice locations and types. The preferred number of splices (field or shop) on any truss is generally going to be zero. But as these are large trusses it is usually not feasible. With large trusses, the length and width of the fabricated assembly will be too large to place on a single load and then splicing will be required. However, alternative shipping options do exist and should be explored if the conditions allow.

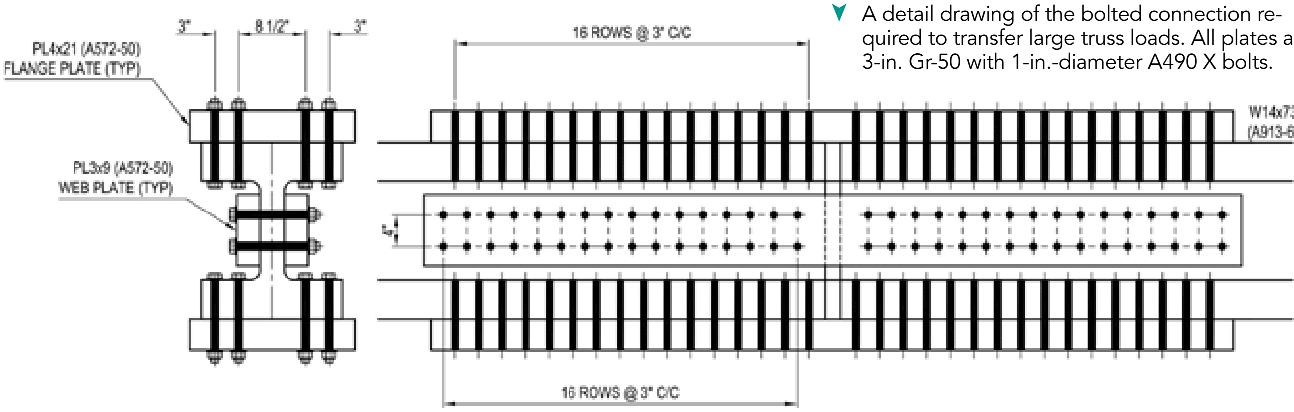
It is often the preference of steel fabricators to weld splices together in the shop, whereas erectors tend to prefer bolted splice

▲ A typical bolted splice connection at the bottom chord of an HSS truss, to be covered later with a steel sleeve, avoiding the initially specificied all-welded connection on site.

▼ Setting the four-strut intermediate support for a 190-ft triangulated HSS truss—one of 17 similar trusses in the new international check-in hall for an airport project.

▲ The airport trusses with cladding and skylight built above each; the bottom chord looks continuous because of the two hidden bolted splice connections covered with a steel sleeve.

▼ A detail drawing of the bolted connection required to transfer large truss loads. All plates are 3-in. Gr-50 with 1-in.-diameter A490 X bolts.



▼ Erection of a 160-ft box truss spanning over an existing building and carrying nine stories of same-length trusses above.

connections. However, when handling large trusses with large loads it is often impractical, even impossible, to transfer the loads through a bolted connection, so field-welded connections must be used. Field welded splices should be avoided as much as possible, especially when the connection is difficult to reach.

Camber. Truss camber is accounted for in the chord members. The fabricator will either roll the chord members or build up the chords out of several straight-segmented members; the latter is often the more economical method. If the required camber in a truss is not uniform or it exceeds the limit that the chord members can be rolled, then the chords will automatically be made of several straight-segmented members that are spliced together to provide the desired camber. These splices are accounted for in the shop.

Member Types and Connections For large trusses, the most practical member types are WF members and HSS members. HSS members are not capable of transferring loads that are as large as WF members, but they are a favorite for architecturally exposed structural steel. For such tubular trusses, splice proposals need the architect's involvement. The result may be an all-welded splice. Alternatively, discreet or hidden bolted connections in the field should be considered.

Large wide-flange trusses can handle very large loads but require more coordination and savvy design, especially at joints where multiple chord and web members are coming together. Deciding which way to orient the WF chord members can impact the framing that surrounds the truss. Deck support, in-framing connections, and lateral bracing are all affected by the orientation chosen.

Special Assembly. Fabricators may arrange to have the erector do a practice assembly before the steel is shipped to the site. As these large trusses require coordinated rigging and shoring with precise connections, there is no room for error on site. This will keep the erection schedule from being affected due to fit up issues. A large splice plate will require a long lead time to measure, fabricate and ship. Also, by being able to quickly assemble these trusses, the erector is able to keep the job site safer for all trades.

Some complex trusses, particularly 3D trusses, can be fabricated more effectively by assembling jigs in the shop to maneuver these frames. Being able to access welding locations easily can make the worker's job much easier and can also allow for a cleaner weld, which is vital for exposed truss connections.

Large steel trusses can be beastly when their main role is transferring significant vertical loads and beautiful when they span notable public spaces. Either way, the four factors described above apply.

The Beauty

For the HSS triangulated steel beauty (see image on previous page) situated in a new airport facility, the 190-ft span had one intermediate support. The priority was limiting the weight of the largest truss segment and encouraging the use of splices that would speed up installation. The result was three segments (two splices) for each of the 17 trusses.

At the splice location, the top chords are hinged and the bottom chord is a hidden multi-bolted continuous joint (see image on previous page). The latter was initially specified as all site-welded, but the hidden "ugly" bolted connection, which was covered with a sleeve and field-finished, sped up construction and met aesthetic requirements. Initially proposed by the fabricator, the entire team adopted the solution. It optimized mobilization of site equipment—one tower crane and one mobile crane—and coordination with other trades such as deck and curtain wall.

Since the truss is triangulated, special arrangements were required to rotate the truss segments during fabrication, transport them on their "back" to the site for safety reasons and flip them back in position before erection. Two segments were assembled on the ground and lifted into position on a temporary tower before erecting the last segment.

The Beast

In the two-story deep-beast (see image on previous page) the transfer of large vertical loads resulting from the interruption of two 45-story tall columns, drove the design. The maximum compressive and tensile forces were 8,500 kips and 3,500 kips, respectively! Consideration for splice location was mainly determined by the weight of the pieces for transport and erection.

The need for pre-assembly was essential. Base plates and gussets were machine finished. Joints in contact bearing needed to have 75% of the entire contact area in bearing and a separation of no greater than 0.02 in. To reduce the weight, high-resistance steel and compact wide-flange sections were used (ASTM A913 grade 65 W360×421, W360×634, W360×1086) along with high-strength bolts (A490 1⅛ in). All shop welds were complete joint penetration. Compression and tension splices were bolted.

While dealing with large trusses, collaboration between architects, engineers, contractors, fabricators and erectors is key to optimizing the location and types of splices, the method of cambering, the member types and the assembly of the trusses from start to finish. ■

*This article is a preview of Session N10 "Working with Large Trusses" at NASCC: The Steel Conference, taking place March 25-27 in Nashville. Learn more about the conference at **www.aisc.org/nascc**.*