conference preview

WHAT YOUR FABRICATOR WISHES YOU KNEW ABOUT HSS CONNECTIONS

BY KIM OLSON, P.E.

Make your HSS designs more economical by taking the right steps.

IT IS A COMMON MISCONCEPTION that structures using hollow structural sections (HSS) are more expensive than those comprised primarily of open sections.

One reason for this belief is that wide-flange members are usually less expensive than HSS on a per-pound basis. However, in most axially loaded applications, an HSS member will overcome such cost differences because the efficiencies that it brings to the job will more than outweigh any per-pound cost increase. And remember that material cost is only one component of a project's structural cost. Fabrication also contributes to the total cost, and in the case of HSS members it can represent a sizable expense. But most fabrication costs, like the devil, are in the (connection) details. Below are some tips that can help reduce your HSS detailing cost and, subsequently, your HSS cost as a whole.

Shear Connections

Shear connections represent the majority of connections on a typical job. Wide-flange-beam-to-HSS-column connections may be a single-plate, WT, double-angle or a through-plate shear connection. The first three connections listed have approximately similar costs. A through-plate connection, however, can be up to three times more expensive than a single-plate connection. This is due to the large amount of work required to create aligning slots on opposing faces of the HSS members, permitting a plate to pass through the tube and to weld each wall. In addition, there are constructability considerations in erecting beams between shop-attached through plates, so it is common to field weld the through plates—which further contributes to the cost. In spite of these costs and erection difficulties, in a recent Steel Tube Institute study, fabricators report that through-plate connections are still widely specified by engineers, with many firms using the through-plate connection as their standard detail connection to an HSS member.

With a three-times cost premium, it is more cost-efficient to increase the wall thickness of the HSS by one-eighth or one-quarter of an inch and connect to the face of the HSS, rather than specifying a thinner-walled HSS with a through plate connection. It is important to note that using ASTM A500 Grade C or ASTM A1085 also increases the efficiency of connections. Because of the increased yield strength and increased wall thickness (for A1085), engineers will achieve greater capacity out of a single shear-plate connection to the face of an HSS column and decrease the need for the costly through-plate connection. Through-plate connections should only be specified if axial loads are transferred through the joint.

Moment Connections

Standard (non-seismic) moment connections between wide-flange beams and HSS columns can be detailed as a cut-out plate connection, a through-plate connection, a direct complete-joint-penetration (CJP) welded connection or a direct partial-joint-penetration (PJP) weld connection. In the case of the CJP and PJP welded connections, the flanges of the wide-flange beam are welded directly to the face of the HSS column. This often requires a thicker HSS wall than would be necessary for a cut-out plate or through-plate connection. Even taking into account the increased wall thickness, a direct PJP weld is by far the most economical connection. In the STI study, fabricators indicated the direct CJP weld, through-plate connec-

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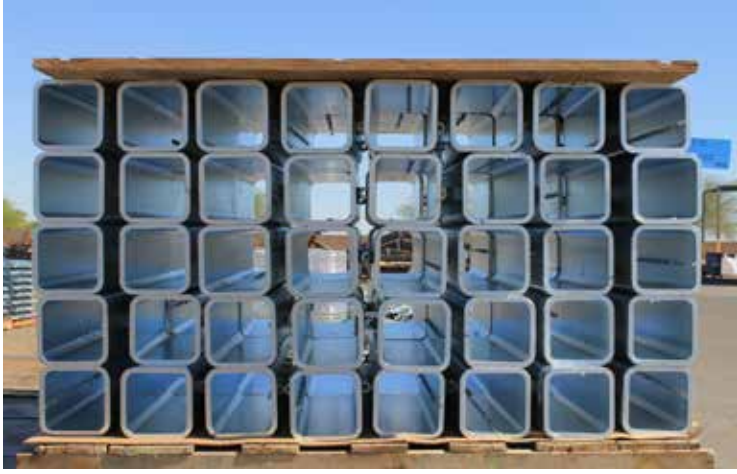

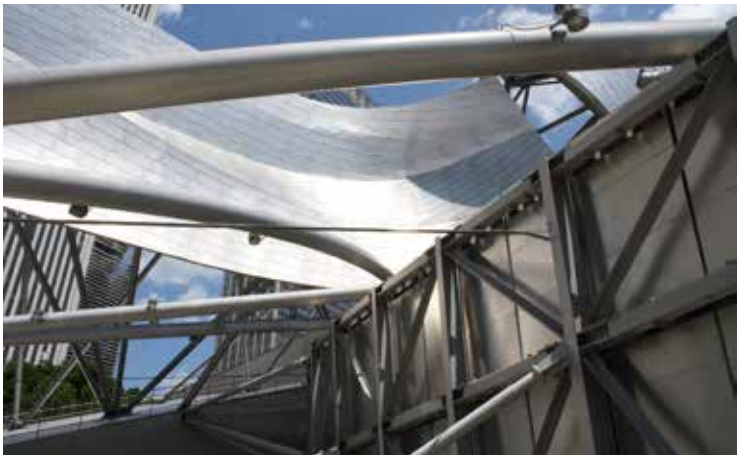

tions and cut-out plate connections were approximately similar in cost. The STI study, however, did not include inspection costs which can be quite high for a direct CJP weld connection as they are usually incurred by the owner, not the fabricator.

HSS-to-HSS Connections

HSS are often specified as truss members for their aesthetics and efficient member capacities, and there are several things to consider to achieve an economical truss design.

Panel points. The lowest-weight truss does not necessarily equate to least cost of the fabricated truss. Fabrication costs factor heavily into the completed truss cost due to its connections; therefore, selecting a truss profile with the fewest number of panel points will be the most efficient choice, even if that means specifying heavier chord members.

Matched vs. stepped. When welding rectangular truss members, the connection can be described as "matched" or "stepped." A matched connection occurs if the widths of the tubes being connected are equal. For example, connecting an HSS6×6 branch member to an HSS6×6 chord member creates a matched connection. If the branch member is smaller in width than the connecting chord, it is a stepped connection. For example, connecting an HSS4×4 branch member to an HSS6×6 chord member creates a stepped connection. A stepped connection is preferred as it leaves a landing on the flat of the chord member to make an economical fillet weld connection. In a matched connection, especially if the tube and/or corner radius are large, welding may require a steel backing or a backing weld to close the root of the joint. A matched connection using smaller members may not require backing, but may require a flare bevel groove weld. These welds, while fairly economical, are less efficient than fillet welds.

K-type connections. This connection type, where two branch members intersect the chord member at the same point, can be specified to be "gapped" or "overlapped." A gapped connection, which is less expensive, allows for a gap between the branch members where they intersect the top face of the chord. Thus branch welding can occur independently and only one bevel cut of each branch member is required. The gap also provides a small amount of fit-up tolerance and allows the truss to be tack welded and entirely assembled prior to final welding to ensure correct fit-up. If the branch members overlap partially or fully, a stronger joint is achieved but it comes at a significant increased fabrication complexity and cost. These connections should only be considered when branch loads are so large they require load transfer directly between branches, not just through the chord.

CJP welds. CJP welds are generally not required and should be avoided in truss-type connections. In an HSS-to-HSS connection, backing cannot be used for a CJP weld due to the lack of access to the inside of the tube unless the connection occurs at the member end. CJP welds made without backing require special fit-up, special inspection procedures and welder pre-qualification. It is usually possible to develop the required connection strength using fillet or PJP welds.

When designing with HSS, it is good practice to consider connection requirements when sizing HSS members, whether you are designing the connections or delegating the work. By considering HSS connections while sizing members, a designer will find that fillet welds and connections to the face of HSS columns will generally be adequate for typical joints. Specifying the quick answer will always cost the project big bucks in the end. ■

This article is a preview of Session N91 "What Your Fabricator Wishes You Knew About HSS" at NASCC: The Steel Conference, taking place April 13-15 in Orlando. Learn more about the conference at www.aisc.org/nascc.