

Following these 17 tips will help engineers experience architecturally exposed structural steel as a pleasant interactive process—not just a challenge.

The Three C's of AESS

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Photos in this article have been provided by the authors.

ARCHITECTURALLY EXPOSED STRUCTURAL STEEL (AESS)

A mix of art, science and know-how, introducing the issue of *personal preference* for what is considered aesthetically pleasing while remaining technically sound.

Whether your AESS project is the canopy of a retail store, the atrium in an office building, the passenger area of an airport, or the long-span roof structure of a sports complex, three key factors should be addressed to ensure a successful outcome:

- Good Communication
- Elegant Connections
- Reasonable Cost

Engineers strive to design structures in which loads flow efficiently to the ground. The loads are happy. The building is stable and durable. End of story. Creating an *aesthetically pleasing structure* is not part of the curriculum, let alone conceiving elegance in the design of connections. Yet, with AESS, structural engineers become part of a triangle of communication with the architect and the fabricator, which greatly affects connections, their design and cost. This interactive design process is very different from the more linear process associated with “standard” structural steel that is hidden from view and where the architect steps back from involvement in the process. When AESS is used, the architect sees the exposed connections as part of the design expression of the project.

Adapting to the new requirements in the design of AESS is really not that difficult. In this article, we propose 17 tips that we hope will make your involvement with AESS a fulfilling experience.

Communication

A fabricator once explained that an architect specified “nice-looking” connections with a “smooth” finish for the exposed part of a school. As one can imagine, such vague language caused anguish for the poor engineer who was somewhat caught between two world views.

“Nice-looking” connection and “smooth” finish mean something quite different to the architect, engineer and fabricator.

- ▲ **Left:** An example of a helical weld on a large tubular member. Was this part of the specification?
- ▲ **Above right:** There is a sense of balance and attention to detail on this relatively complex connection. The detailer definitely added his magic touch.
- ▲ **Below right:** A simple taper on the flanges and lightly rounded corners on the shear tab go a long way to add elegance to this repetitious detail in an airport.

Communication must be structured to provide a clear set of guidelines for the vision of the outcome of the AESS project.

Consider the following tips to improve communication right from the specification.

1. Have an AESS section in your specification, preferably as a subdivision of the Structural Steel Division. The AESS section will provide separate requirements for the exposed steel from what is normally included for concealed structural steel. However, all the standard structural steel requirements apply.

2. Adopt a category approach. A four-category system (AESS1 through AESS4) such as proposed in the article “A Categorical Approach” (April 2008 *MSC*, available at www.modernsteel.com/backissues) and now part of the *CISC Guide for Specifying Architecturally Exposed Structural Steel* (available at www.cisc-icca.ca/aess) can help clarify requirements for differentiating AESS as a function of the building type, distance of view, surface treatment and budget. Another useful set of characteristics was proposed in the AISC AESS supplement published in the May 2003 issue of *MSC*, which is also available online.

3. Moderate discussions with the architect and the fabricator in the early stages. It is essential to have face-to-face meetings with the architect, engineer and fabricator to discuss expectations of the form, fit and finish of the steel. Depending on the work, it may be desirable to meet at the fabrication shop or in front of AESS that has previously been completed by the fabricator.

4. Be clear in your specification about what you will accept as a substitution. Once the loads are happy, limits need to be



- ▲ **Above left:** The tight tolerances at these intersecting W-shapes give the group of members a clean line.
- ▲ **Below left:** The major portions of this canopy truss were created using shop-welded connections. These discrete bolted connections are inconspicuous and allowed for an easier site assembly.
- ▲ **Right:** Concealed bolted connections have been used to join the round HSS members of this truss to the column connection of a large atrium.

placed on the range of members used in the structure. For example, the surface of an ASTM A53 pipe may be different than an ASTM A500 HSS, and a helical weld on a large tubular member has a different look than a longitudinal weld.

Connections

An award-winning fabricator with several successful AESS projects in his portfolio had this message for engineers: “If they [engineers] could spend some time making the connections more elegant, simplifying them so steel is used only where it’s really needed, that would help express steel’s attributes effectively and aesthetically.”

Connections that are to be exposed must be designed differently

than those that are concealed. It matters a great deal if the overall design will use bolted or welded connections. The connection design will inform, and be informed, by the overall requirements for the design of the structural system, as part of the architecture.

Aside from specifying on which side of the connection the bolt heads should appear, consider the following tips to improve the integration of the connections in the structure.

5. Make stitch welds continuous. For longer distances, the same visual effect may be achieved by using caulking.

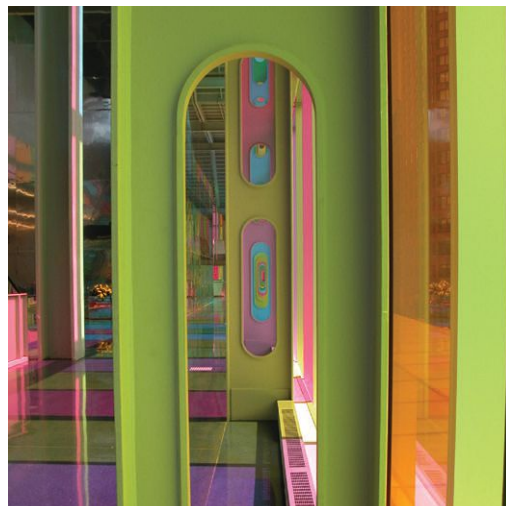
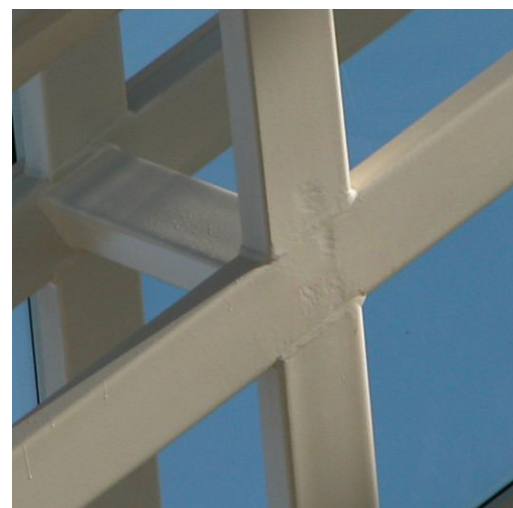
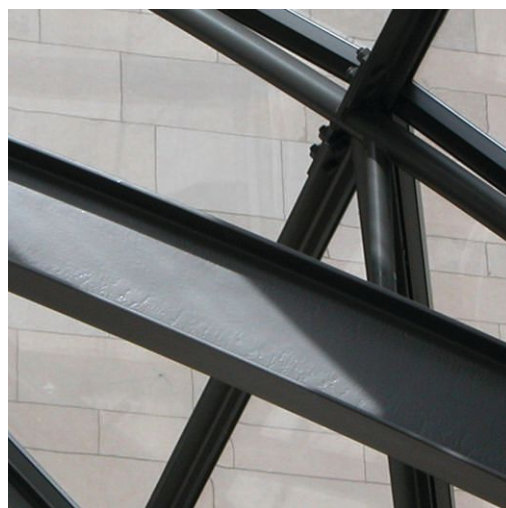
6. Reduce the number of pieces used in connections, including stiffeners. For example, consider using a single plate connection instead of double angles or several plates. Another option could be making the web thicker and eliminating the need for a stiffener, or applying a stiffener only to the less visible side.

7. Modify the elements in or near the connection with rounded, tapered, curved edges. For example, apply a taper on the top and bottom flanges of a W-shape, or round the corners on a shear tab or other plate element.

8. Minimize the gaps between the pieces and make sure they are consistent. For example, apply a maximum gap of 1/8 in. Large gaps and inconsistency result in a messy appearance.

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- ▲ **Above:** This connection uses a casting to more simply connect the members of this large vertical truss. There has been no effort to conceal the joints between the castings and the round HSS members. This saves fabrication cost and can be seen as a design detail.
- ▲ **Middle:** This is a successful AESS use of galvanized steel. Make sure architects understand that galvanizing is not a finish but a protection system with a unique patina that will yield a non-uniform look.
- ▲ **Below:** It's hard to imagine that one of these striking subassemblies is a "one-off inspection."

- ▲ **Above:** The connection of mechanical pipe to a casting. These welds must be fully filled and ground smooth in preparation for high gloss finish.
- ▲ **Middle:** This is located in a skylight that is situated far overhead. Although the web has not been ground smooth, nobody can really see this. This is acceptable and also reduces cost.
- ▲ **Below:** The steel is actually finished with grey paint. The color is provided by the light coming through the glazing. The openings in the web add interest without excessive additional expense. The result leaves no one indifferent.

- ▲ **Above:** This truss structure uses a fairly thick intumescent coating for its fire protection. This has changed the way the connections have been detailed. There is certainly no need to do excessive grinding as it simply wouldn't matter.
- ▲ **Middle:** This welded connection is located high above in an atrium. Although the connection has not been filled to be smooth before painting, its high location does not necessarily warrant the expense as it will not be seen.
- ▲ **Below:** Here's a use of wide-flange sections with simple connections to support the roof overhang.

9. **Redesign obtrusive spliced bolted connections and complex field welded connections into more discrete bolted connections.** As one example of this, the splice plates between HSS could be designed in the longitudinal direction rather than in the transverse direction and bolted all around.

10. **Hide as many burdensome details as possible.** In a large truss, one may be able to do this by turning the HSS longitudinal weld away from view, or choosing HSS members that will connect nicely together by avoiding large eccentricities or requiring additional plate reinforcements.

11. **Consider using an aesthetically pleasing casting as a connecting element.** This option may be economically feasible when the cost of fabrication exceeds four times the cost of the steel in the connection, when you have high stress concentrations or seismic requirements at a node and when there is repetition to amortize the cost of developing the mold (if the casting is not already a standard product).

Cost

When architects and engineers ask fabricators how much an AESS structure will cost compared to standard structural steel, the typical answer is, "it depends." And the range can be great, from a cost premium of 25% compared to standard structural steel for a simple retail store to 50% for an atrium in an office building, and perhaps more than 100% for high-end airport structures.

Be specific and communicate early on what exactly needs to be done. Realize that not all AESS need to be created equal; understanding the impact of viewing distance and use, and allowing the fabricator to use simpler methods, can reduce some costs.

Look up the table in the *MSC AESS* supplement, referred to in point 2, for additional guidance. Also keep in mind the following tips to control and reduce cost.

12. **Specify a minimum surface prep-**

aration of SSPC-6. Insufficient surface preparation has often translated through the finishes and impaired the final product resulting in additional cost.

13. **Take into account the final coating, fire protection or corrosion protection system before specifying surface treatments.** There is no need to fuss over details if they are to be covered by a thick intumescent coating. Conversely, if the desire is for a high-gloss finish, surface imperfections need to be minimized.

14. **Avoid excess grinding and other surface treatment in remote or less visible locations.** In other words, apply the 20-ft rule. If you can't see it, such remedial surface treatment is unnecessary.

15. **Avoid specifying samples that are expensive.** Be reasonable and detailed on the kind of sample truly needed. Indicate whether it's a 3D rendering, a small physical sample of steel with the finish applied, a "first-off" inspection, a scaled-down mock-up of a detail or assembly, or a full-scale mock-up that remains for the entire job.

16. **Check for availability, especially if large round tubes are used.** This can delay the project and add cost for specialty work. The largest round HSS that is widely available is 20 in. in diameter and generally not rolled as often as smaller tubes. A recent update to ASTM A500 now allows sizes larger than 20 in., whereas previously you would have had to familiarize yourself with pylon and pole standards.

17. **Don't over-specify.** Not all AESS steel need be to created equal. Many lovely AESS projects are an amalgam of standard shapes, attentively designed details and a simple coating system.

We both "like" to see well-designed AESS in projects, from the quaint café to the iconic project. Please visit our interactive photo gallery on Facebook for some additional tips, links and content designed to enhance your AESS experience.

See you on [facebook.com/aess4u](https://www.facebook.com/aess4u). **MSC**

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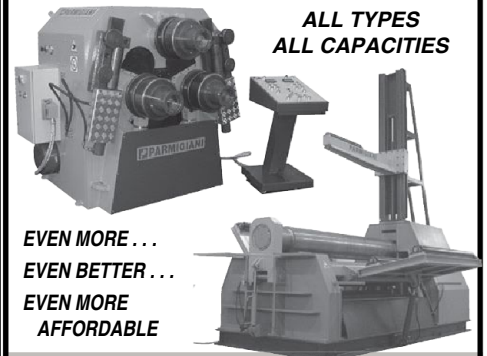
...or not! Tell us—in other words, "like" it or not—on Facebook. We have posted several architecturally exposed structural steel (AESS) images on [facebook.com/aess4u](https://www.facebook.com/aess4u) revealing expressed steel in varying contexts. We have already published our comments and encourage you to join us.

Why do we want you to "like" our AESS images on Facebook? To exchange and advance a design domain that often results in great expectations and wonderful exposed structures, but other times causes communication distress, which is immediately reflected on the connections and ultimately the cost. If you like the image of the detail, the partial structure, the overall building, "like" it and comment. And if you don't, say why! And why not share your own personal favorite AESS detail image? We'll be sure to tell you what we think.

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