

Planning ahead for temporary support
improves constructability and enhances safety in steel erection.

Structural Steel Erection Aids

BY VICTOR SHNEUR, P.E.

WHEN FIELD CONNECTIONS are bolted, holes already are present so that the erector can safely pin and bolt the connection. When field connections are welded, supported members need to be correctly located and held in position until the entire welded connection or a sufficient portion of the connection is complete. Erection aids are needed for these welded connections to make steel erection safe, efficient and accurate. For each particular case erection aids are individually selected and can be erection bolts, temporary angle seats, erection lugs, etc. This article will discuss their selection and show several examples.

Erection aid preferences may vary from area to area and from company to company. When a fabricator works with the same erector, over time they get to know each other's expectations. If a new erector is going to work on a project, it is always a good idea to discuss erection aids prior to starting the work. In all cases erection aids should comply with OSHA requirements.

It is important to remember that not all field-welded structural elements require erection aids. Normally, there are small items that are welded immediately and can be supported by other means. For example, plates or angles can be temporarily clamped to beam flanges. The erector also may choose to proceed without erection aids if the removal of the aids and restoration of the surfaces would require a lot of extra work. The erector needs to plan the temporary rigging or support system to safely align and hold the member until the permanent connection is made.

Eliminating Erection Aids

When connections are fully or partially bolted, or shop assemblies are provided to eliminate field-welded connections, erection aids may not be needed. Also, simplifying or reconfiguring connections can reduce or eliminate the need for erection aids. For example, where a cantilever is required at the roof, making the beam continuous over the column will eliminate moment connections for the cantilever and backing beam. Bolting the beam to the supporting column entirely eliminates the need for erection aids for the cantilever. This makes fabrication and erection easier and safer.

Using field-bolted column splices in lieu of CJP groove welded splices for moderate tensile forces and/or moments is another way to reduce the need for erection aids. In this case, it will eliminate eight shop-welded erection lugs per column splice.

The decisions on shop assemblies should be made based on factors that include fabrication, transportation, erection, painting and final appearance. In most cases assembly weight and overall dimensions determine whether or not to proceed with shop assembly. The classic example is trusses. Shallow and short trusses are shop welded; but deep and long trusses are delivered in pieces or segments and assembled in the field.

Deciding on Erection Aids

Because the erector actually erects the steel, he or she is responsible for determining the type and strength of the aids. The AISC *Code of Standard Practice* provides guidance regarding this type of responsibility. This can be discussed at the preconstruction meeting between the erector and the fabricator, then coordinated with the EOR and the architect. The decisions need to be made prior to proceeding with detailing.

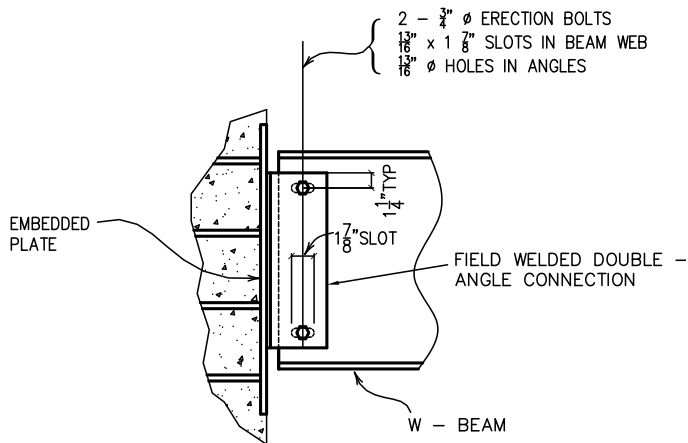
Shop and erection drawings should show all erection aids and necessary instructions for the erector. For example, if removal of erection lugs is required at a CJP groove welded column splice after its completion, that should be noted on the erection detail. Late decisions will result in revisions of the drawings that are time consuming and may delay detailing. Typically, the erector and the fabricator work together to find the most efficient and easy way.

Why Erection Aids Need to be Coordinated with the EOR

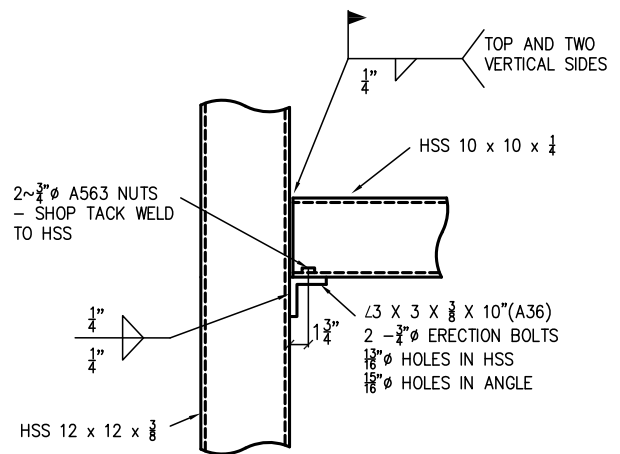
Even erection aids mostly related to constructability and safety can affect structural member design and they always should be coordinated with the EOR. This can be done at the preconstruction meeting, through the RFI system, or during the approval process.

Here are two scenarios when erection aids may affect the design:

1. Holes for erection bolts in a beam's tension flange may reduce the bending strength of the beam. For example, OSHA holes for joist connections for continuous beams can have such an effect.
2. An erection aid in a high-seismic project cannot be welded in the protected zone as specified in the AISC *Seismic Provisions*.



▲ **Figure 1:** Wide-flange beam to concrete wall connection. Two erection bolts are used as an erection aid. Long-slotted holes are provided for difference in tolerances for concrete and steel frame. Typically bolts are left in place. Note: Connection must be designed for maximum adjustment.



▲ **Figure 2:** HSS beam-to-HSS column connection. Erection seat is provided. Oversized holes in the angle allow for tolerance. Because a field weld is not required at the bottom of the HSS 10x10, the seat does not need to be removed unless it is required by the architect or engineer.

▼ **Figure 3:** HSS beam-to-HSS beam connection. Typically, erectors prefer to have the seat angle at the bottom. For this particular case the bottom of the frame was exposed to view and erection aids used at that location would need to be removed. The erector suggested having erection aids at the top.

Why to Coordinate with the Architect on Erection Aids

The architect typically reviews erection aids for:

1. Interference with other building components. For example, erection lugs for a CJP groove welded column splice may need to be removed because of interference with column closure.
2. Overall appearance of the frame and connections in particular when structural steel is designated as architecturally exposed structural steel.

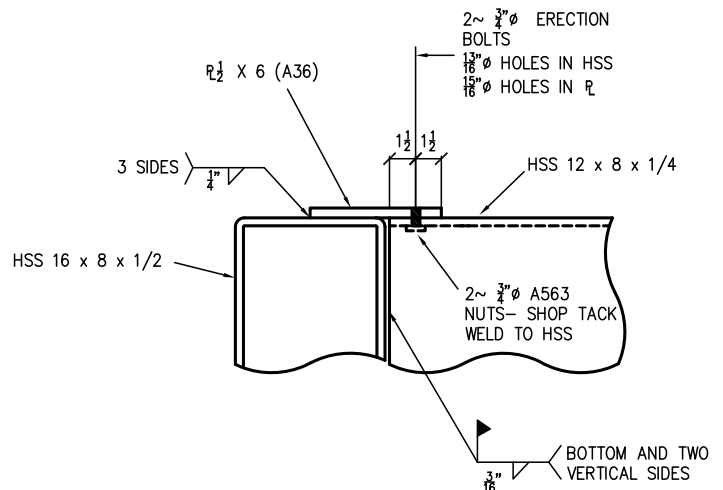
Per Section 10.4.1 in the AISC *Code of Standard Practice*, addressing architecturally exposed structural steel, “If temporary braces or erection clips are used, care shall be taken to avoid the creation of unsightly surfaces upon removal. Tack welds shall be ground smooth and holes shall be filled with weld metal or body solder and smoothed by grinding or filing. The Erector shall plan and execute all operations in such a manner that the close fit and neat appearance of the structure will not be impaired.”

Items to Consider When Erection Aids Are Specified

The selection of erection aids is an important decision involving many factors including:

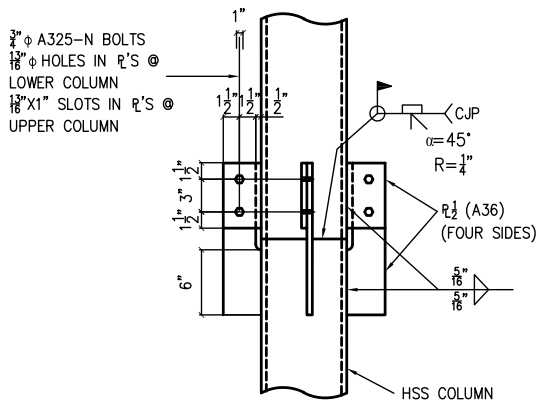
1. Safety.
2. Erection procedure.
3. Applied loads.
4. Stability.
5. Effect on supporting members.
6. Requirements for removal of the aids and fixing surfaces after connection completion.
7. Tolerances.
8. Accessibility.
9. Erector and fabricator preferences.
10. Cost.

The figures accompanying this article show a number of examples of erection aids and options associated with them.

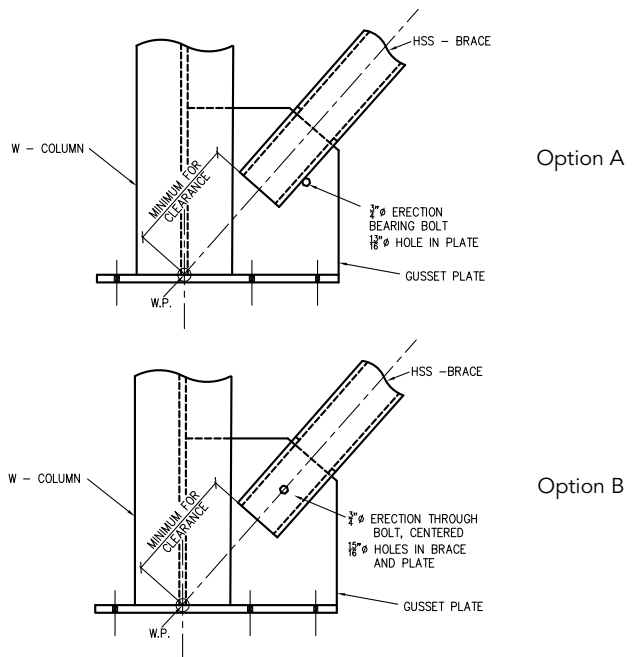


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▲ **Figure 4:** HSS column CJP groove welded splice. Erection lugs are provided on four sides. This temporary connection should have adequate strength and provide column stability during erection until the CJP groove weld is complete. See “Column Alignment and Stability During Erection” in Part 14 of the *AISC Manual* for specific recommendations. Note that erection lugs often are required to be removed at HSS columns for appearance or interference reasons.



▲ **Figure 5:** HSS brace-to-gusset plate connection. Both Option A and Option B use erection bolts at gusset plates. In Option A the brace is held in position by a bearing bolt and by brace bearing at the ends of the slots in the brace at the bottom gusset plate and by the bearing bolt at top gusset plate. In Option B through-bolts at gusset plates support the brace. Option B is more expensive for fabrication because of the holes and long bolts. Using oversized holes for this option can provide helpful fit-up tolerances.

Special Cases

Special erection aids not needed for steel-to-steel connections are still required in some cases to facilitate construction. For example:

Special Case 1: Lifting lugs or lifting plates may be required to rig heavy structural members like trusses, plate girders, and large columns. They are designed based on the weight of the member and the lifting procedure. Complete information for each, including location, size, pin holes, and welds, must be provided to the fabricator to detail on shop drawings. These details need to be coordinated with the EOR and the architect if the lugs are not to be removed. Coordination between the EOR and the erector’s own engineer, whether on staff or a consultant, is important to verify that the concentrated loads during erection will not overstress originally specified welds and web.

Special Case 2: Embedded plates to formwork attachments. This can be done by providing holes at the corners or tack welding nuts in the shop. While this looks like a small item, providing attachments for embedded plates will simplify the construction and can eliminate unnecessary work later on because of mislocated plates.

Quality Control and Quality Assurance

Typically erection aids are provided only for temporary use to facilitate handling and erection, but their Quality Control and Quality Assurance should be the same as for all other connections. In Part 14 of the *AISC Manual* the article “Lifting Devices” states: “The safety of the structure, equipment, and personnel is of utmost importance during the erection period. It is recommended that all welds

that are used on the lifting devices and stability devices be inspected very carefully, both in the shop and later in the field, for any damage that may have occurred in handling and shipping. Groove welds frequently are inspected with ultrasonic methods (UT) and fillet welds are inspected with magnetic particle (MT) or liquid dye penetrant (PT) methods.”

Conclusion

The cost of erection aids is small for any project, but they directly affect accuracy and efficiency of erection and, more importantly, the erector’s safety. They need to be considered at the beginning of each project and carefully planned by the design and construction team.

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AISC offers a number of publications that include information on this topic.

- ▶ AISC 303-10, *Code of Standard Practice for Steel Buildings and Bridges*, available as a free download at www.aisc.org/freepubs.
- ▶ 14th Edition *AISC Steel Construction Manual*, available for purchase at www.aisc.org/manuals.
- ▶ AISC 3rd Edition *Detailing for Steel Construction*, available for purchase at www.aisc.org/manuals.
- ▶ *AISC Steel Design Guide 23: Constructability of Structural Steel Buildings*, available at www.aisc.org/dg as a free download for AISC members and for purchase by others.