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## Non-Destructive Testing of PJP Groove Welds

**Is ultrasonic testing effective for partial joint penetration (PJP) groove welds?**

Ultrasonic testing (UT) is a common test method used to evaluate complete joint penetration (CJP) groove welds because it can provide a full volumetric evaluation of the weld—i.e., top to bottom. This does not apply to PJP groove welds, due to the loss of the sound beam at or below the root of the weld, in the un-welded portion of the joint. As a result, AWS D1.1 does not provide procedures or acceptance criteria for UT of PJP groove welded joints.

While UT cannot be used to evaluate the weld itself, it will detect the root, and this information can be used to determine the depth of the PJP groove weld. In this case, UT could be deemed effective, but for root depth determination only.

*Keith Landwehr*

## Field Modifications

**We have a project in which field modifications are required. How does AISC recommend that these be proposed, evaluated and approved?**

Field modifications are sometimes necessary. When that is the case, it is important to recognize that the erector and general contractor want to—and must—be able to proceed with the work, and the engineer of record, building official and owner must be satisfied that such modifications are made in an acceptable manner. We believe the following recommended process satisfies both of these concerns.

OSHA requirements for steel erection refer to a "competent person." While those requirements and their usage of that term do not address specifically the question at hand, we make use of that phrase here as well.

The need for, design of and performance of field modifications should be supervised by a competent person working for the erector. Generally, this is the engineer the erector uses to design and supervise field operations. Thereafter, field modifications should be reported to the engineer of record in a timely manner for review and approval.

Review and approval by the engineer of record is necessary because the erector is aware only of the requirements of the structure in general and the specific needs of the erection operation. In other words, only the engineer of record knows the loading and performance requirements of the final completed structure. When a change is required to make a field modification acceptable for the final completed structure, the erector must make the required changes. In-process discussions between the erector's engineer and the engineer of record should occur whenever possible to facilitate the foregoing process and minimize the need for changes after the fact.

*Charles J. Carter, S.E., P.E., Ph.D.*

## Required Stiffness of Braces

**AISC 360 Appendix 6, Section 6.3.1b gives Equation A-6-8 for the required stiffness of a nodal flange brace. The denominator contains $L_b$, which represents the laterally unbraced length of the beam. If I brace the beam at 10 ft on center, my required stiffness is not large. However, if I brace the same beam at 1 ft on center, the required stiffness increases by a factor of 10. Why does the required stiffness increase if I provide more braces?**

The buckled shape between braced points is half a wavelength. If braces are placed at a 10-ft spacing, that is forcing the lowest lateral-torsional buckling mode to have a half-wavelength equal to 10 ft. When the braces are placed at a 1-ft spacing, they must have a greater stiffness in order to force the first LTB buckling mode to have a 1-ft half-wavelength. The stiffness required is larger for that reason. For more information on this topic you can refer to the discussion starting in the last paragraph of page 15 of "Fundamentals of Beam Bracing" in the 1st Quarter 2001 AISC *Engineering Journal* (**www.aisc.org/ej**).

*Brad Davis, S.E., Ph.D.*

## Shop Drawing Schedule

**Section 4 of the AISC *Code of Standard Practice* clearly states how much time the fabricator must allow for the contractor/owner to return the drawings for approval. Is there a similar section of the AISC *Code* that states how long the contractor/owner must give the fabricator to produce the detailed shop drawings?**

The AISC *Code of Standard Practice* does not specify a time allowed for the fabricator to supply shop drawings. There are a number of factors that affect the shop drawing process, such as timely receipt of design drawings and specifications that are released for fabrication as outlined in Section 4.1. The Commentary to Section 4.1 states that a submittal schedule is a recommended item of discussion in a pre-detailing conference.

AISC *Code* Section 4.2, last paragraph, states that the fabricator shall provide its schedule for submittal of shop and erection drawings when requested, to facilitate timely flow of information between parties. The fourth paragraph of the Commentary to Section 4.2 explains this requirement further. Often, the reviewer is challenged to provide sufficient staffing to keep pace with the fabricator's submittals.

The issue of schedule is primarily dictated by the contract agreed upon by the fabricator and the owner's designated representative for construction. Some items that can influence the speed at which shop drawings can be produced include the level of completeness of the design information, changes made subsequent to the start of shop drawing production and the number of shop drawings required for a particular project.

*Keith Landwehr*

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## Requirements beyond AISC 360

**In our office we consider it good practice to limit the weld thickness for welds on two sides of a connection plate to no more than the thickness of the plate. In other words, we limit the strength of a weld to not more than the shear strength of the base metal times the area of the weld leg (weld length times weld size). We recognize that this conflicts with and is more conservative than the AISC *Specification* requirements, which do not consider failure through the fusion zone as an applicable limit state. When the load to be transferred would require a larger weld than described above, we require the fabricator to provide longer welds and plates, thus reducing the weld size to meet our practices. Please confirm that we are within our rights to impose such conditions and expect the contractor to comply with this practice without asking for additional payment.**

Yes you can, but should you?

The AISC *Specification* provides minimum requirements for the general case, and specific cases may require engineers to apply their own judgment to address special requirements or atypical conditions. Yours does not seem to be a case of an atypical condition or a special requirement. Rather, it seems like an unnecessary and archaic conservatism—it has been known for many decades that fillet welds don't fail on the fusion surface—and your client likely would not appreciate how you are spending his or her money.

In some instances your "good practice" would preclude certain designs. For example, when designing a single-plate shear connection per Part 10 of the AISC *Steel Construction Manual*, the weld is intended to develop the strength of the plate in order to accommodate simple beam end rotations. The welds required to do this are ⅝ times the thickness of the plate on each side and this does not apply the phi- or omega-factors contained in the AISC *Specification*. If you were striving to develop the strength of a plate for a given design load, the required fillet welds might be even greater relative to the plate thickness.

You must also keep in mind that decisions have consequences, and if you plan to impose requirements beyond those found in the AISC *Specification* you should clearly state these additional requirements in the contract documents so that they can be accounted for at the bid stage. In the words of Oliver Wendell Holmes, Jr., "The right to swing my fist ends where the other man's nose begins." You can impose virtually any requirement you wish as long as it does not violate the law, but the contractor cannot be expected to meet requirements that could not have been anticipated at the bid stage if in doing so he is also expected to absorb the cost of the additional requirements.

To avoid conflicts and misunderstanding, unusual requirements such as this should be made prominent in the contract documents. I think you should abandon this one, however.

*Larry S. Muir, P.E.*

## Groove Weld Orientation

**In the case of a CJP groove-welded beam flange-to-column flange joint, can the bevel be prepared from the top side of the beam flange or the underside of the beam flange?**

Generally, groove-welded joints can be made in various positions. Bevel on the top or bevel on the bottom essentially provides the same result. Furthermore, codes do not specify or restrict the welding position, even for applications such as high-seismic or high-wind. That said, welding processes and welding electrodes have limitations on their ability to be used in all positions. As an example, submerged arc welding (SAW) is limited to the flat position. Some flux-cored arc welding (FCAW) electrodes are designed to be used in the flat and horizontal positions only, while others are designated as useful for all positions. Also, when reviewing the figures of the prequalified weld joints in AWS D1.1 or the AISC *Steel Construction Manual*, you will note that in some cases the intended position used for welding will dictate the amount of bevel and the root opening required.

In many cases, ease of execution and economy dictate the means and methods chosen to perform welding. Using the example that you provided, welding from the top of the joint is considered to be quicker and more economical. When the bevel is on the top side, the bulk of the weld metal is placed in the flat position rather than the overhead position, whereas when the bevel is placed on the bottom side the bulk of the welding is done from the bottom, or overhead, position. Overhead welding typically involves smaller diameter electrodes, lower deposition rates, less accessibility and welders specifically qualified to weld in the overhead position. These items would impact schedule and cost.

For all the above reasons, it is common to allow the contractor to choose the correct weld joint configuration based on the electrode they intend to use and the position that they intend to weld in.

*Keith Landwehr*

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If you have a question or problem that your fellow readers might help you solve, please forward it to us. At the same time, feel free to respond to any of the questions that you have read here. Contact Steel Interchange via AISC's Steel Solutions Center:

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