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CONNECTION DESIGN RESPONSIBILITY—HOW'S IT BEEN GOING?

A look at how the changes in the most recent version of the *Code of Standard Practice* are transforming the steel industry.

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ONE OF AISC'S GOALS is to provide a common understanding between the design community and the steel construction industry.

This is partially accomplished by setting standards for steel design through the work of volunteer committees such as the AISC Committee on Specifications, which creates steel standards like the *Specification for Structural Steel Buildings* and *Seismic Provisions for Structural Steel Buildings*, among others. These documents are focused on mandatory provisions related to the design and construction of steel buildings.

And then there is the AISC *Code of Standard Practice*, which is developed by the AISC Committee on the Code of Standard Practice. It is different than the aforementioned design documents in that it provides trade practices that can be followed directly. It also allows that specific provisions to the contrary, contained in project contract documents, take precedence. In other words, the *Code* is written for the "typical case" and recognizes that specific projects may require or benefit from a different arrangement based upon specifics of that project.

The content of the *Code* is based on actual practices of the structural steel design community and construction industry, and therefore is updated periodically to reflect current trends. The latest version of the *Code* was introduced in 2010, and one of the major revisions made in that version appears in Section 3.1.2. It added the option for the owner's designated representative for design to delegate connection design to a licensed engineer working for the fabricator. In addition to this revision, the 2010 *Code* contains several updates that are identified in the Preface to the standard.

A New Option

As the 2010 version has now been available for several years, it is time to explore how it has affected the industry. But first, let's review some of the key updates.

The addition of the Section 3.1.2 option mentioned above (Option 3) was expected to be especially impactful. Section 3.1.2 states that the owners designated representative for design, generally the structural engineer of record (SER), shall indicate one of three options for each connection in a project:

Option 1) Provide the complete connection design shown in the structural design drawings.

Option 2) Structural design drawings or specifications stipulate that the connections be selected or completed by a steel detailer.

Option 3) Connection design is delegated to a licensed professional engineer working for the fabricator.

Besides listing it as an alternative in Section 3.1.2, related *Code* provisions were put in place to promote proper implementation of Option 3 and to create an understanding between the SER, the fabricator and the licensed engineer they retain. For example, Section 3.1.2 lists the information that the SER must provide on the structural design drawings and specifications, as well as a specific procedure as to how the process should proceed when Options 2 or 3 are specified. The SER must provide or address the following:

- Restrictions on the types of connections that are permitted
- Load information
- Whether the loads are at service-load or factored-load level
- Whether LRFD or ASD is used
- Substantiating connection information that must be provided to the SER, if any

Regarding this last point, this information is generally not required for Option 2. Option 2 requires a detailer to complete the connection design using tables (possibly from the AISC *Manual*) or schematic information provided in the structural design drawings. For this reason, "substantiating connection information" would not be required for Option 2 other than, perhaps, a listing of what tables the connections were selected from if schematic information were not provided on the structural design drawings.

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For Option 3, the *Code* requires the fabricator to submit representative samples of the required substantiating information in a timely manner early in the connection design process. Then the SER must respond in a timely manner, in writing, that the samples are consistent with requirements in the contract documents—or if not, which modifications are required. Another part of the substantiating connection information is written confirmation from the licensed professional engineer working for the fabricator that the shop and erection drawings properly incorporate the connection designs. The fabricator must somehow link the substantiating connection information to the related connections on the shop and erection drawings for the SER review.

The *Code* provides several reminders that none of these requirements replace the SER approval outlined in Section 4.4. The 2005 *Code* Section 4.4 stated that the shop and erection drawings must be submitted to the SER for review and approval. The 2010 language, requiring that final substantiating connection information also be submitted, should provide the SER with the calculations and background needed to check that the connection design is completed accurately. Section 4.4 also clarifies that the SER has the final authority in the case of a dispute over the method used or accuracy of a connection design. The SER should, however, keep the lines of communication open throughout the process so that the connection design is a coordinated effort with the fabricator—and in the case of Option 3, a coordinated effort with the licensed professional engineer working for the fabricator. Unfortunately, due to the nature of the reporting relationships (see Figure 1), there is no direct relationship between the two engineers (SER and licensed engineer) who need to work together. Therefore, it is up to the SER, architect, general contractor and fabricator to ensure that their project does allow the SER and licensed engineer in responsible charge of the connection design to cooperate and communicate effectively.

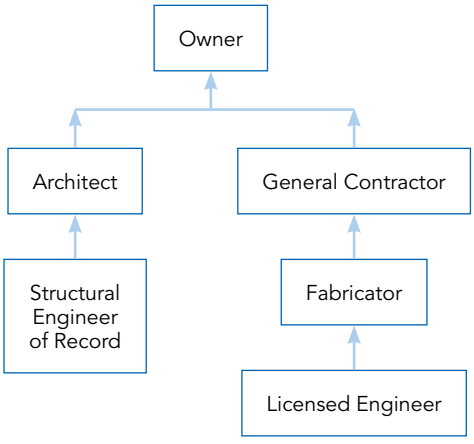

Figure 1. Common contractual relationships for steel design and construction.

There are also new criteria in Section 4 – Shop and Erection Drawings that directly relate to the successful implementation of Option 3, such as pre-detailing conferences and final approval of the connection design. The value of a pre-detailing conference after the structural steel fabrication contract is awarded is addressed in Commentary Section 4.1. This allows the SER and the fabricator to discuss connection considerations, including the loading and types of connections that are appropriate, as well as the schedule.

Section 3.1.2 and Current Practice

AISC contacted a select list of connection designers to see how the new provisions are working. Here's what we learned.

As many (if not most) are already aware, the concepts now embodied in Option 3 actually have been in use for many years prior to 2010. It also must be recognized that the variations in the way these concepts have been used are significant. Ultimately, including it explicitly in the 2010 *Code* made it a more viable option and more acceptable because the practice is formalized, coordinated and complete, where it often wasn't before.

As discussed in the Commentary to Section 3.1.2, Option 3 was not only a practice that had been in use, but it had been employed only in certain areas of the U.S. One result of adding this new alternative is that its use has become more widespread in the eastern and Midwestern states. It has also spread to other parts of the country including the west coast, where connection design has traditionally been completed by the SER. Delegating a portion, or all, of the connection design can be a time-saving (and thus a cost-reducing) solution for the SER, but their time and cost to create design requirements for the connections, actually design the connections and then review and approve them must still be recognized. Option 3 only works well if the SER:

- provides the necessary information to design the connection
- considers connection design requirements when sizing, orienting members and specifying loads on the design documents
- provides realistic and complete loading information to avoid connection designs that are overly conservative, expensive or impractical (e.g., reactions on each member instead of generalized requirements)
- provides specific information on transfer forces, concentrated loads near the ends of beams and other such information, the omission of which could lead to deficient connection designs

These needs came back on every survey response we got, even though we didn't ask specifically about these concerns!

We also found that there is often a combination of the three options used in projects, such as Options 1 and 3, where the SER chooses to design some of the more complex or special connections and delegate the remainder to the licensed engineer working for the fabricator. In this case, the SER provides specific design details, sometimes with schedules to simplify the information, in the design documents for those connections the SER is designing. When this combination approach to options is used, it is important for the SER to clearly differentiate between what is a completely designed connection and what is a "representative

Feedback from Experience

Here are some key points we heard from engineers we contacted about their experience with Option 3 in the 2010 AISC *Code of Standard Practice*.

- A major handicap occurs when a delegating SER reduces the connection design criteria and related information provided on the design drawings—e.g., perhaps an all-encompassing note is used in place of providing the reactions on each member. These notes tend to be conservative resulting in expensive connections—and often, unbuildable details—that could otherwise be engineered much more cost effectively if the actual reactions were provided. In some cases these connections become nearly unbuildable when the actual reaction would result in a simple and easily installed connection. In some other cases these notes can result in a dangerously deficient connection design, such as an overlooked high concentrated load near the end of a beam. Provide the actual reactions!
- What about the case when a fabricator submits the connection designs their engineer performed and the SER requires changes that are not consistent with the requirements in the contract documents? Not changes to conform to the contract requirements, but rather changes that exceed the contract requirements. The delegated engineer and the SER may disagree, and the *Code* gives the SER the final authority. However, there are two things that must be kept in mind in this situation:
  - First, this scenario is creating changes to the contract requirements. Changes incur costs and a bill should be expected when this happens.
  - Second, and perhaps more subtle, the SER is changing from Option 3 to Option 1. The SER who overrules the delegated engineer is taking back full responsibility for the complete connection design.
- On some drawings, it is difficult to determine what is completely designed and what is a "representative detail," and it would help if this were made clear in the design drawings. When material sizes and some welds are shown along with standard bolt requirements, these are representative, not completely designed.
- When using Option 3, it is of paramount importance that the SER give thought to the connection design requirements when sizing and orienting members. The delegated engineer can't change the framing later.
- Watch out for conservative force schedule requirements that don't provide equilibrium forces and transfer forces. The ugliest connection details you've ever seen can result and these are not in anyone's best interest.
- "Select and complete" in Option 2 is not the same as "design" in Option 3. If you delegate work that involves design calculations, it is Option 3, not Option 2.
- Some SERs seem adamant that they should not have to be responsible for reviewing and approving design calculations and shop drawings when Option 3 is used. The *Code* is clear (as are the courts) that this position is counter to the fact that only the SER knows the completed structure and can serve to protect the life safety of the public.

detail" on the design drawings; this avoids confusion. Options 2 and 3 are also used together (e.g., the detailer can select and complete the simple shear connections from tables in the AISC *Manual* while the connection design is delegated for the connections that require engineering work, such as bracing and moment connections, to the fabricator's engineer). It should be noted that the *Code* is clear that the intent of Option 2 is *not* for the detailer to perform engineering design work. Rather, Option 2 is limited to using tables or schematic information provided by the SER to select or complete the connection design.

As a good sign that the new *Code* language is helping in actual projects, we learned that the actual language used in contract documents related to connection design often reflects the language from Section 3.1.2. For example, a connection shown on the design drawings as "completely designed" indicates that Option 1 has been used for that connection and the fabricator has nothing to do with the design. When Option 2 is used for any of the remaining connections on a project, the phrase "select and complete" is often used. If Option 3 is invoked, then the contract documents will indicate which connections must be "designed" by the fabricator's engineer.

The issue of approval and final authority is sometimes questioned in current practice. As written, the *Code* is clear that the SER is responsible for final review and approval of the shop and erection drawings, regardless of which option in Section 3.1.2 is implemented. The *Code* clearly states in Section 4.4 that the owners designated representative for design (the SER) has final authority in the event of a disagreement between parties. Two things merit mention in this regard:

1. This doesn't mean that arbitrary decision-making is permitted. The SER can insist that the requirements established for connection design at the outset of the project be met. Revised or additional requirements added later are changes, and may carry associated costs. As a result, it can easily be seen the importance of clearly defining what is required and permitted when choosing to specify Option 3.
2. What happens if the licensed engineer in responsible charge of the connection design doesn't agree with changes in the connection design mandated by the SER? This is a serious matter when you consider that the SER who does so is essentially converting the connection design back to an Option 1 connection.

Moving into 2016

The revisions to the 2010 *Code* appear to have made for positive steps in the steel connection design process. SERs seem to have embraced the new option 3 language in Section 3.1.2 and it is being used successfully on many projects today. The next *Code* is scheduled for 2016, and a few clarifications are expected to make the process even smoother. ■

This article is a follow-up to the May 2009 Modern Steel *article "Connection Design Responsibility: Is the Debate Over?" by Charles J. Carter*