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steel interchange

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Thin Plates and Welding

I have specified ¼-in. plates to be welded to structural members for aesthetic considerations. Some of the fabricators bidding the project have indicated that there may be issues associated with welding plate that is this thin. They have mentioned weld show-through and distortions as potential concerns. Are these valid considerations? What can be done to address them?

In general, when the company charged with performing the work indicates that they will have difficulty satisfying your expectations, their concerns should be taken seriously and viewed as valid. This does not mean that the issues are insurmountable, but it does indicate that the conditions deserve some greater consideration.

A ¼-in. plate is thinner than what many structural steel fabricators will be used to working with. Their equipment will commonly be set up to deposit a 5⁄16-in. fillet weld to the thicker material, probably a minimum of 3⁄8 in. thick. Both weld show-through and distortion are related to weld size and material thickness.

It may be possible to use different equipment and processes to reduce the amount of distortion, though this will likely increase the cost of the fabrication. Theoretically, a 1⁄8-in. fillet weld could be used, which would produce significantly less heat input than is typically seen in structural steel fabrication. You may also want to consider whether the plate can be stitch welded. Stitch welding will reduce the heat induced in the plate, thereby minimizing distortion.

Another alternative may be to use thicker material, if possible, while still satisfying the aesthetic requirements. Using thicker material might allow the fabricator to use more typical and efficient equipment and processes, resulting in economical fabrication.

Larry S. Muir, PE

The next three items all relate to the choice of seismic system and how this choice relates to complexity and cost. We receive a fair number of questions like the ones below and felt that presenting these three as a group might be instructive.

Seismic Response Modification Coefficient, *R*, Given as 3¼

As a fabricator, we are starting to see buildings in Seismic Design Category C with the seismic response modification coefficient, *R*, given as 3¼ in the General Notes. Will these structures have to satisfy the *Seismic Provisions for Structural Steel Buildings* (ANSI/AISC 341)?

Yes. If you are seeing structural steel buildings using R = 3¼, then I assume that the building is designed as a steel ordinary concentrically braced frame system (OCBF) type B.3 in ASCE 7-10, Table 12.2.-1, and OCBFs need to satisfy the applicable sections of *Seismic Provisions*. Chapter F, Section F1 outlines some of the requirements specific to this particular system, and F1.6 specifically refers to connections. Additionally, there are general requirements in Chapters A through D and quality control and quality assurance requirements in Chapter J, which also need to be considered.

It should be noted that Section A4.1 lists information that must be included in the structural design documents and specifications. Much of this information is intended to clarify the project requirements as they related to the *Seismic Provisions*. If this information has not been provided, then it should be requested. One of the listed items is the designation of the seismic force resisting system (SFRS). If my assumption above is correct, the SFRS should be designated as OCBF.

I will also state that this seems like an unusual choice. Generally, a system not specifically detailed for seismic resistance (R = 3) would be a more economical option for a structure in Seismic Design Category C.

Susan Burmeister, PE

Weight Savings of Intermediate Moment Frames

We are bidding fabrication for a project in Seismic Design Category B. The SFRS is designated as using intermediate moment frames (IMF). This is an unusual system in our area, and we have suggested that it may be more economical to design it so that it isn't specifically detailed for seismic resistance (*R* = 3). It has been asserted that our suggestion would in fact be less economical due to the increased weight of the members. Is this correct?

A: The choice of an IMF with an R = 4.5, as opposed to a system not specifically detailed for seismic resistance with an R = 3, will result in a smaller base shear due to the seismic loads and may also result in lighter members. However, requirements to use moderately ductile beam and column members may reduce or eliminate the benefit relative to weight.

Other requirements related to fabrication, such as requirements to provide qualified or prequalified moment connections, may result in an increased overall cost for the project, even if there is a reduction in weight of the members.

AISC generally recommends choosing systems not specifically detailed for seismic resistance (R = 3) whenever permitted, if the economy of the structure is the primary consideration. AISC has long taken the position that least weight does not correlate to least cost. This applies to seismic design as much as it does to sizing columns to avoid the need for reinforcing at moment connections.

Thomas J. Schlafly

Conveyors in a High-Seismic Area

We are designing steel conveyors in a high-seismic area. For steel ordinary moment frames (OMFs), Chapter 15 of ASCE 7-10 permits the use of R = 1 without having to satisfy the *Seismic Provisions* or R = 2.5 when the *Seismic Provisions* are satisfied. We have reviewed Section E1 of the *Seismic Provisions* and believe that we can take advantage of the higher seismic response factor of 2.5 by simply providing a direct-welded moment connection with CJP (complete joint penetration) groove welds at the flanges. This detail would seem to satisfy the requirement to design the beam-to-column moment connection for $1.1R_yF_yZ_x$. Is there anything we are missing?

The *Specification for Structural Steel Buildings* (ANSI/AISC 360) and *Seismic Provisions* both address the building design, and applying their provisions to nonbuilding structures requires engineering judgment relative to how similar the structure's behavior will be to that of a building, and whether any adjustment should be made to account for the differences.

From your description, I believe you are looking at an OMF system. AISC does not provide requirements related to the range of available systems; these requirements are provided in ASCE-7. You may want to contact ASCE if you have questions related to their requirements. However, it does seem odd to me that a conveyor would be designed to meet Chapter 15. Manufacturing or process conveyors are included in Chapter 13, and treating the conveyors as nonstructural components may be more appropriate. There may be reasons to treat this particular conveyor as a nonbuilding structure similar to a building, but this is not the norm.

Relative to evaluating the R = 2.5 and the R = 1 options, you have not identified all of the potential impacts that using an OMF could have on your project. One mistake engineers sometimes make is that they think the system chapters in the *Seismic Provisions* are self-contained. Section E1 does not contain all of the requirements that will apply to your project. Requirements of Chapters A through D and Chapters I through J will also apply, and even some of the Chapter K requirements could have an impact.

For example, your contract documents will have to satisfy A4. If you do not address all of these requirements adequately, you may have to address RFIs, which could lead to you changing the contract requirements after award. This could lead to revisions to the contract with potential cost and schedule impacts.

Section D2.2 addresses requirements for bolted joints. All bolts will have to be pretensioned, which might be done for a conveyor anyway to prevent loosening, but all faying surfaces in the SFRS (with a few exceptions) will also have to be qualified for slip resistance. If the members are galvanized, the faying surfaces will have to be hand-wire brushed. If the members are painted, they will have to be masked or a qualified paint must be used.

In addition to AWS D1.1, AWS D1.8 must also be satisfied, and quality control and assurance tasks are expanded.

Note that this is not intended to be a complete list but is rather intended to illustrate some of the provisions that might impact the work.

There are also practices that could make the structure more economical that you might overlook if you are not well-acquainted with the *Seismic Provisions*. For example, you state that the connections must develop the expected strength of the beam, $1.1R_yF_yZ_x$. This is not exactly correct. There are exceptions to this default requirement that might apply to your structure and might lead to a more economic result.

Generally, AISC encourages engineers to use steel systems not specifically detailed for seismic resistance whenever possible. This guidance applies to buildings, so the base shear is derived from R = 3 instead of R = 1. AISC has no position on the relative benefit of moving from R = 1 to OMF with R = 2.5. In my opinion, unless you are already familiar with the *Seismic Provisions* and have already worked on projects required to meet the *Seismic Provisions*, you might be better off going with the R = 1 option.

Larry S. Muir, PE

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