If you've ever asked yourself "why" about something related to structural steel design or construction, *Modern Steel Construction's* monthly Steel Interchange column is for you!

Welding to Old Steel

We are designing the rehab of several old buildings. In at least two of them, we have structural steel framing that we want to weld to. One was built in about 1901, the other in 1912.

We are in the agonizingly slow process of getting the CM to contract with a testing firm to test the steel for weldability. The CM is not overly concerned because he says that almost any steel is weldable—it's just a matter of picking the right electrode. Sounds too good to be true. Any comments?

Question sent to AISC's Steel Solutions Center

The contractor's statement may be mostly true, but not always if the material in question is steel rather than wrought iron, which was common in structures constructed in the late 1800s and early 1900s. A paper titled "Field Welding to Existing Steel Structures" by David T. Ricker was published in the *Engineering Journal*, first quarter, 1988. This document is an excellent primer on the subject. A copy of the paper can be accessed at **www.aisc.org/epubs** (a free download for AISC members).

The Ricker paper makes applicable comments on the subject as follows:

- ➜ The use of low-hydrogen welding electrodes and preheating can improve the weldability of most base metals.
- ➜ If it is suspected that the existing material is wrought iron, welding should be avoided if possible.

Ricker also makes suggestions as to possible investigations, which may give a better idea of the weldability, to consider while you are waiting for the testing to be performed.

- ➜ Examine the existing steel work to see if welding was used during the original fabrication and erection, or if the structure has been successfully welded onto previously.
- ➜ A simple on-site test can be made by welding a lug of weldable steel to the existing member and beating it with a hammer.

There is probably not a sure answer as to whether the material can be welded to successfully. However, the more information you can gather prior to construction, the less surprise can occur.

Kurt Gustafson, S.E., P.E.
American Institute of Steel Construction

Trial Size for Composite Beam

I am curious about the origin/calculation behind the equation for a trial beam size shown on page 5-26 of the AISC LRFD manual.

Question sent to AISC's Steel Solutions Center

The expression takes the calculated moment for the composite beam and divides it by a distance. That distance is from the center of the concrete slab to the center of the steel beam or $[(d/2) + Y_{con} - (a/2)]$. This results in an estimate of the effective concrete flange force.

The effective concrete flange force, when divided by ϕF_y, gives the area of steel beam required. ϕ used in the denominator cancels the ϕ in the expression $M_u = \phi M_n$ in the numerator. (Alternatively, we could have eliminated the ϕ in the denominator if we would have used M_n in the numerator.)

That area is multiplied by 3.4 lb/sq. in. per foot [the same as 490 lb/cu. ft (the unit weight of steel)/144].

Hence, the basis of the expression is to determine the beam weight required to resist a certain concrete flange force based on the yield strength and unit density of steel.

Sergio Zoruba, Ph.D., P.E.
American Institute of Steel Construction

Steel Plate Shear Walls

The Canadian Institute of Steel Construction recently presented a seminar on steel plate shear walls at our office. They mentioned that there is an AISC committee studying this subject. Is there any information on design procedures and *R* values for seismic load determination in accordance with IBC 2000 or IBC 2003?

Question sent to AISC's Steel Solutions Center

The 2003 IBC does not specifically address special plate shear walls and we cannot speculate as to the intention of future inclusions of IBC. The 2005 AISC *Seismic Provisions* (as shown in the final draft) will contain a section on steel plate shear walls (SPSW), which will note that where the applicable building code does not contain design coefficients for SPSW, the provisions of Appendix R shall apply. Appendix R in the final draft of the provisions indicates an $R = 8$ for this seismic load resisting system.

Kurt Gustafson, S.E., P.E.
American Institute of Steel Construction

Seismic Category

I attended an AISC staggered truss seminar, and I have questions regarding some braced frame requirements: We are doing an industrial structure in California, Zone 3. We cannot find anywhere in the 1997 UBC, 2001 CBC, or AISC seismic provisions whether we can use an OCBF in a Zone 3, or if the lateral system must be a SCBF. There is not a lot of difference between the two, but we have approximately six braced bays on six different levels. To be able to use our OCBF spreadsheet would be helpful.

Question sent to AISC's Steel Solutions Center

The model building code, or jurisdictional code, will cite the AISC *Seismic Provisions* for seismic load resisting systems based on their own seismic event criteria. For example, IBC

2000 and IBC 2003 mandate the use of the AISC *Seismic Provisions* for SDC D or higher.

If the code requires you to use the AISC seismic provisions, then you can either choose OCBF or SCBF based on the *R* value you wish to use in the design. Keep in mind that SCBF are expected to withstand significant inelastic deformations and have increased ductility over OCBF due to lesser strength degradation when compression braces buckle. Unlike OCBF, SCBF contains specific provisions for compression slenderness, percentage limits for tension bracing, and width-thickness ratios for stiffened and unstiffened elements. There are additional detailing requirements as well. We generally recommend SCBF for better seismic performance; however, OCBF has significantly fewer detailing requirements and tension-only bracing may be used. Therefore, it may be preferred for industrial-type frames.

Sergio Zoruba, Ph.D., P.E.
American Institute of Steel Construction

Composite Filled HSS

I am interested in using concrete filled HSS, but I am concerned about load transfer between the steel and concrete. Specification I2.4 addresses concrete encased columns but is silent on concrete filled HSS. Commentary I2.4 states that bond is commonly used on fixed offshore platforms, but no guidelines are available for other structures.

My application is "other structures," and in my application the load is applied to the HSS. Would shear connectors be required to ensure composite action, or can bond be used on other structures? What would be used for shear connectors on HSS, and what are the design criteria? How is bond stress evaluated?

Question sent to AISC's Steel Solutions Center

Based on the section reference stated, it is obvious that you are referring to the 1999 LRFD specification. Section I2.2 of the 2005 AISC *Specification for Structural Steel Buildings* does cover the design of filled composite columns. If you can use it instead, you will be able to take advantage of the latest information available, which includes the information you seek.

Load transfer between the steel and concrete is covered in Section I2.2e of the 2005 specification. Therein, it is stated that "transfer of force from the steel section to the concrete core is required from direct bond interaction, shear connection, or direct bearing. The force transfer mechanism providing the largest nominal strength may be used. These force transfer mechanisms shall not be superimposed."

It probably would not be feasible to get shear connectors on the inside of an HSS; at least at any distance from the end of the member. Therefore, you will probably have to depend on the bond transfer mechanism for filled composite HSS section. The commentary to Section I2.2e of the *Specification* gives an approach for determining the direct bond interaction.

Copies of the 2005 specification and commentary are available to download free at **www.aisc.org/2005spec**.

Kurt Gustafson, S.E., P.E.
American Institute of Steel Construction

Shear on Anchor Rods

Is there any new thinking or literature regarding anchor rods loaded primarily in shear? This is especially important in metal buildings where a shear key welded to the base plate normally does not exist. How do you handle the effect of oversized holes in base plates? I normally ignore this (unless the loads are high) and assume the shear forces are essentially resisted by the anchor rods.

I can come up with mechanical or welded connectors of some type, but it seems to be a needless expense, given that failure of anchor rods in shear does not seem to be a recurring problem. I was told that there are some new guidelines from AISC, but I haven't found them on the web site.

Question sent to AISC's Steel Solutions Center

The historic position is that the anchor rods should not be required to transfer the column shear force unless there is no other means to accomplish the shear transfer. The draft of the revision to AISC *Design Guide 1: Column Base Plates* provides the following insights:

1. The use of anchor rods to transfer shear forces must be carefully examined, with particular attention to the manner in which the force is transferred from the base plate to the anchor rods if it is intended to resist shear with the anchor rods.
2. Considerable slip of the base plate can occur before the base plate bears against the anchor rods, unless the details address limiting the potential for such slip.
3. Due to placement tolerances, not all of the anchor rods will receive the same force unless special provisions are made to equalize the load to all anchor rods, such as with plate washers with standard holes field welded to the base plate between the anchor rod nut and the top of the base plate.
4. Bending effects in the anchor rods may be significant.

The finalized revision of the design guide will expand upon these items further and provide more guidance.

Kurt Gustafson, S.E., P.E.
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Steel Interchange is a forum for Modern Steel Construction readers to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine.

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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 at solutions@aisc.org or at 866.ASK.AISC.