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!

WUF-W Connections for Special Moment Frames

(Discussion of the subject by three seismic experts)

The WUF-W connection shown on page 3-29 of the FEMA 350 (2000) document is listed therein as a prequalified connection for special moment frames, but is not a prequalified connection in AISC 358-05. There is a major flaw in the design rationale of the WUF-W connection given in FEMA 350 on page 3-31.

The beam plastic hinge point is located at one-half the beam depth, db/2, from the face of the column. In addition to the beam plastic moment at this hinge point there is a shear, V_{pb} equal to:

$$V_{pb} = 2(1.1R_yM_p)/(L\text{-}d_b) + V_g$$

The first term is the shear due to the seismic moments per AISC 341-05 Equation 9-1. The second term, V_g, is the shear due to gravity load. L is the clear span, and d_b is the beam depth.

This hinge-point shear generates a moment at the face of the column so that the total moment at the face of the column, M_f, is:

$$M_f = M_{pr} + V_{pb}d_b/2$$

However, the beam is already at its maximum moment capacity M_{pr} at the hinge point. Either the beam web or the beam flanges must be reinforced to accommodate the increase of the moment at the face of the column caused by the hinge-point shear.

Ralph M. Richard, Ph.D., P.E.
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The performance of the WUF-W connection is based on SAC testing and not on analysis. The purpose of the analysis method for determining M_c, M_f, and other quantities in FEMA 350 is for use in determining the forces needed to calculate the panel zone and continuity plate strength requirements. It is recognized that the moments M_c and M_f are larger than M_{pr}, however testing has shown that the connection works for the conditions defined in FEMA 350.

It is believed that the adequate performance is due to the combination of the improved flange welding and reinforcing fillet, the strong web connection provided by the combination of the CJP groove-welded web with the welded shear tab, and the effect of local restraint at the column face.

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The AISC Seismic Provisions Task Committee has been working with the SAC/FEMA documents in updating AISC 341. In parallel, the AISC Connection Prequalification Review Panel has been developing AISC 358, which provides prequalified moment connections for use in Special Moment Frames per AISC 341. The first edition of AISC 358 addresses the reduced beam section (RBS) connection and some end plate moment connections (for conditions without floor slabs). Other connections in FEMA 350, such as the WUF-W, were considered by the committee, but were not included. The Committee responsible for AISC 358 has begun work on the next edition and will be considering this and other connection details further.

James O. Malley, S.E.
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Column Base Anchorage

Is there a minimum strength in tension required between a column and a footing even though the column will never see any tension?

Question sent to AISC's Steel Solutions Center

The AISC *Specification* does not contain such a provision, though some tension loads will likely be introduced during erection. It is a good idea to consider erectability in the design, but the engineer is not required to do so with one exception. The use of anchor rods is required by the OSHA Erection Standard (four anchor rods minimum, must be able to withstand a bending moment of a 300 lb ironworker 18 in. from the face of the column.) The resulting tension that occurs to resist this moment must be accommodated in the base anchorage of the column to foundation. Refer to ACI 318 Appendix D for anchor rod embedment requirements. AISC *Design Guide 10* also provides guidance about column base considerations for erection.

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

Pipe or Tube

What ASTM specification should I use for steel pipe? Should I use A53 or A500? I previously used A53, but I read in an article in MSC that we should no longer designate pipe as, say, 4 in. diameter schedule 40, but rather as HSS 4.5×0.237, and that I should specify A500 instead of A53. Which is correct?

Question sent to AISC's Steel Solutions Center

The AISC specification defines HSS as "square, rectangular or round hollow structural steel section produced in accordance with a pipe or tubing product specification." Both ASTM A53 and ASTM A500 are permitted materials for use under the auspices of the AISC specification, but note that these are different products (A53 covers pipe with F_y = 35 ksi in Grade B, while A500 covers HSS Rounds with F_y = 42 ksi in Grade B). You can use whichever best suits the need of your application in accordance with AISC pecification requirements, and is readily available. If you choose to use ASTM A500 shapes, the designation should be in accordance with that Standard (ex. HSS4.000x0.237). If you choose to use ASTM A53 shapes, the designation should be in accordance with that Standard (ex. Pipe4 Std.). One final note: when specifying round HSS, only the cross sections that match up with pipe cross sections are generally available.

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Historic Shape Information

I am working on modifications to an existing hotel in Manhattan that was built about 1928. I have access to some of the erection plans which indicate beam sizes for which I have no reference data, including a "CB" designation. Where can I find information on old rolled shapes?

Question sent to AISC's Steel Solutions Center

The CB refers to Carnegie Beam named for Andrew Carnegie of Carnegie Steel Company the forerunner of U.S. Steel. The CB sections were an early designation for wide-flanges produced by U.S. Steel.

AISC's *Design Guide 15* is a reference for historic shapes and Specifications and includes section properties for these shapes. Also, the AISC Shapes Database CD V13.0H (H for historic) contains the same information. These are both available to AISC members as free downloads at **www.aisc.org/epubs**.

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Preheat Requirements

What are the preheat requirements for fillet welding a 3½ in.-thick base plate to a W14 × 283 column?

Question sent to AISC's Steel Solutions Center

Preheating requirements for welding operations are not covered under the AISC specification, but rather by AWS D1.1. Look to Table 3.2 of AWS D1.1 for "Minimum Prequalified Preheat and Interpass Temperature" based on the grade of material, the welding process and the thickness of the material. AWS Section 3.5.1 indicates that the minimum preheat or interpass temperature applied to a joint composed of base metals with different preheats from Table 3.2 (based on category and thickness) shall be the highest of these minimum preheats.

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Beam Splice in Protected Zone

Are there any criteria in AISC 341-02, *Seismic Provisions for Structural Steel Buildings*, that would prohibit a beam splice outside the protected zone for an IMF in SDC D?

Question sent to AISC's Steel Solutions Center

The term *protected zone* was not used in AISC 341-02. However, the intent was present in Section 7.4. In AISC 341-05, the term *protected zone* is used and has explicit requirements for each type of system.

Section 9.4 in AISC 341-02 also mentions that abrupt changes in beam flange area are not permitted in plastic hinge regions. Ultimately, you should consider whether the splice will interfere with the expected inelasticity in the protected zones and let this guide you as to the acceptability of a splice.

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Bolt Hole Sizes

1. **Is there any difference in hole diameter for an expansion bolt vs. a normal bolt?**
2. **Is there any difference in hole diameter for a tension control bolt (TC), vs. a normal bolt, vs. a slip critical bolt (SC)?**

Question sent to AISC's Steel Solutions Center

1. The AISC specification does not cover the design or installation requirements for expansion anchors into concrete, which are generally proprietary components meeting a manufacturers test criteria. I presume that what you refer to as "normal bolt," would be an ASTM A325 or A490 bolt (which is not comparable to an anchor in concrete). Permitted hole types for the A325 and A490 bolts, such as standard, short slot, long slot, or oversized, could vary depending on the direction of load application and type of joint considered. The hole sizes for a particular type, however, are not permitted to vary beyond the maximum sizes given. See Section J3 of the AISC *Specification for Structural Steel Buildings* for "normal" bolting requirements.
2. No. Hole diameter is independent of the bolt type, be it "normal" or TC. Regarding the comparison to SC: SC is a connection type, not a bolt type. Again look to Section J of the Specification for information as to the different types of joints used in structural connections and the hole types permitted for each application. The RCSC specification also provides guidance on selection for joint type and corresponding hole usage.

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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:

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