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! Send your questions or comments to solutions@aisc.org.

Protected Zones in SMF

During shop drawing review, we noticed that we had located a gravity beam such that it fell in the reduced beam section (RBS) protected zone in the moment frame beam. The connection is a single-plate shear connection with bolts to the gravity beam and fillet welds to the moment frame beam. Is this acceptable?

No. Connections should not be located within the protected zone for a special moment frame (SMF). The concern within protected zones is with items that may cause discontinuities that precipitate fracture in zones for which significant inelastic behavior is expected, as is the case in the zone you have in your RBS moment frame. Thus, welds or other items that can introduce discontinuities are not allowed. It is a good idea to sketch protected zones to scale in the design phase to ensure that the framing details have connections that fall outside the protected zones.

Heath Mitchell, P.E.

Secondary Moments in Truss Design

Is it permissible to analyze a truss for member forces with the center line distance of the members, but then design the web members with the actual length of the web members between the top and bottom chords, not the center line length, taking advantage of the connection restraint?

This is a matter of judgment that the engineer of record must make, but I recommend the paper "Secondary Stresses in Trusses," by R.S. Nair, which was published in the Fourth Quarter 1988 Engineering Journal. (Available as a free download to members at www.aisc.org/epubs. There is a nominal charge for non-members.) The question you ask concerns how to analyze the truss and use the results with convenient design assumptions. The conclusions in the paper state that the analysis assumptions and design process must be consistent, and mostly this concerns whether moments must be considered or can be ignored. If you move the pin to the face of the chord for convenience in the design of the web member, you then must consider the impact of this decision on the chord loading and design.

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

Drain Holes for HSS

A tower fabricated with HSS has leg splices that are made with bolted butt plates. There are no drainage or venting holes at the butt plates, but I observed water weeping out of a connection and there has been a history of corrosion in the HSS just above the butt plates. Are there any recommendations in AISC literature for sealing or venting such a condition?

Section M2.10 in the 2005 AISC Specification requires drain holes when water can collect inside HSS or box members, or that the member be sealed or suitably protected. The Specification is a free download at www.aisc.org/epubs.

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

Steel Plate Thicknesses

Is there an AISC table that gives available steel plate thicknesses by material grade?

You may be interested in Table 2-4 on page 2-40 of the 13th Edition AISC Steel Construction Manual, which organizes various plate/bar material by its applicable thicknesses and indicates the preferred (most common) material for each thickness. In addition, Part 1 of the Manual discusses how to properly specify plate products, including thickness intervals.

Martin Anderson

Firm Contact

Where can I find specific tolerances for gaps created when I have a double angle clip bolted to a beam web? When the bolts are tightened, a gap still exists between the angle face and the beam web, though I do have "firm contact" as described by RCSC.

An allowable size or length of gap is not provided in the AISC Specification or the RCSC Specification. Bolts must be installed at least snug tight, so there must be at least firm contact between the plies. The RCSC Specification defines firm contact as "the condition that exists on a faying surface when the plies are solidly seated against each other, but not necessarily in continuous contact." From this, gaps can exist at portions of the connection. However, firm contact is not satisfied if the gap is continuous over the length of the connection.

In connections involving very thick plies it is not uncommon to actually break a couple bolts trying to pull the plies together and eliminate gaps. When this happens and the plies are in contact over some length of the connection, it is usually decided that the firm contact requirement has been met.

If the plies are not especially thick and significant gaps are present, it is likely you have dimensional (fit-up) problems in the members and have not satisfied the firm contact requirement. In such cases a fill (pack, shim) can be used. Up to a ¼-in.-thick fill can be used without affecting the strength of the connection.

Larry S. Muir, P.E.

Vent Hole for Galvanizing

Steel fabrication for a steel pipe column dictates that a steel base plate and steel cap plate be shop welded to each end of the pipe column. The steel pipe column is to be hot-dip galvanized after the welding operations have been performed, and the hot-dip galvanizer is requiring vent holes. Is there any guidance you can give or any references you can cite that would be helpful?

The American Galvanizers Association has much information compiled on its website (www.galvanizeit.org) that will help you. The specific URL that has guidance on venting requirements—as well as many other topics relevant to galvanizing—is www.galvanizeit.org/aga/designing-fabricating/design-considerations/.

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

steel interchange

Heat Cambering

I'm trying to put a 2-in. camber in a 54-ft-long ASTM A992 W27×114 beam using heat not exceeding 1,200 °F. It's a rather large beam size, and I'm wondering what size rosebud to use, what pattern to heat, and any other info that might help me camber this beast. Any suggestions for where to apply heat (flange or web), a good geometric pattern to follow, etc.?

Following is an excerpt of FHWA-IF-99-004 Oct 1998, which is titled "Heat Straightening Repairs of Damaged Steel Bridges: A Technical Guide and Manual of Practice."

Torch Tip Size and Intensity

The amount of heat applied to a steel surface is a function of the type of fuel, the number and size of the orifices as well as the adjustment of the fuel pressure and intensity at the nozzle tip. Selecting the appropriate tip size is primarily a function of the thickness of the material. The goal is to rapidly bring the steel in the vicinity of the torch tip to the specified temperature, not just at the surface, but throughout the thickness. Once this condition is obtained at the initial heating location, the torch should be moved along the path at a rate that brings successive sections of steel to the specified temperature. A tip that is too small for the thickness will result in an inadequate heat input at the surface that does not penetrate adequately through the thickness. If the tip is too large, there will be a tendency to input heat into the region so quickly that it is difficult to control the temperature and distortion. Table 2.1 is a general guide for selecting a tip size. However, this table is only a guide. Intensity of the torch, ambient temperature, steel configuration, access, and fabrication details may influence the choice of tips. Adjustments can also be made in the torch intensity to improve the heating response. A hotter flame is helpful if the configuration of the steel tends to draw heat away from the spot of heating. A less intense flame allows for a slower pace as the torch is moved along the path.

Steel Thickness (in)	Steel Thickness (mm)	Orifice Type	Size
< ¼	6	Single	3
⅜	10	Single	4
½	13	Single	5
⅝	16	Single	7
¾	20	Single	8
1	25	Single	8
		Rosebud	3
2	50	Single	8
		Rosebud	4
3	75	Single	5
> 4	100	Single	5

Table 2.1. Recommended torch tips for various material thicknesses.

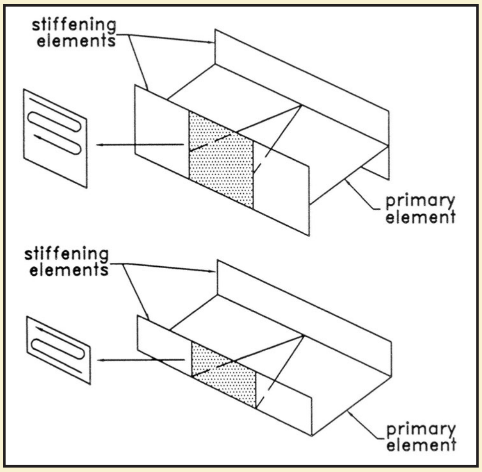

Fig. 2.11. Heating patterns for wide flanges and channels bent about their major axes (Category S).

The intensity may be adjusted so as to compensate for variables encountered in the field.

Heating Patterns

One of the keys to heat straightening is appropriate heat patterns to fit the yield zones of the steel. Basic patterns were illustrated in Figs. 2.10-2.15. Yield zones, where the steel has inelastically deformed, occur in regions of sharpest curvature. Some practitioners have a tendency to heat in a broader zone, but this again is a case of more being less. Stay with the recommended patterns and do not expand them. Heat straightening is a cyclic process. The movement occurs gradually by contraction during cooling. Sometimes 20 or more heating cycles are required to completely straighten a damaged member. Since a heating pattern usually covers only a portion of the yield zone, the pattern should be shifted on a cycle-by-cycle basis. The significant portion of a single heating pattern array should be in the yield zone with fewer heating cycles near the edges and more near the center where curvature is the sharpest. Also, only make a single continuous pass through a given zone during one heating cycle. Going back and re-heating before the material has cooled interrupts the contraction process. The heat straightening predictability and effectiveness is consequently reduced.

Tom Schlafly

The complete collection of Steel Interchange questions and answers is available online. Find questions and answers related to just about any topic by using our full-text search capability. Visit Steel Interchange online at www.modernsteel.com.

Heath Mitchell is director of technical assistance, Charlie Carter is vice president and chief structural engineer, Tom Schlafly is director of research, and Martin Anderson is Steel Solutions Center information specialist at AISC. Larry Muir is a consultant to AISC.

Steel Interchange is a forum 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.

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:

Steel Solutions Center

One East Wacker Dr., Suite 700
Chicago, IL 60601
tel: 866.ASK.AISC • fax: 312.803.4709
solutions@aisc.org