If you've ever asked yourself "Why?" about something related to structural steel design or construction, *Modern Steel*'s monthly Steel Interchange is for you! Send your questions or comments to **solutions@aisc.org**.

steel interchange

Shop Primer

We have always specified shop-primed steel, but we are being challenged as to why. Can you provide more information related to this topic?

The AISC Engineering FAQs address this issue:

10.1.1. When must structural steel be painted?

As stated in the 2005 AISC *Specification* Section M3.1: "Shop paint is not required unless specified by the contract documents." Therefore, fabricated structural steel is left unpainted unless painting requirements are outlined in the contract documents.

In building structures, steel need not be primed or painted if it will be enclosed by building finish, coated with a contact-type fireproofing or in contact with concrete. When enclosed, the steel is trapped in a controlled environment, and the products required for corrosion are quickly exhausted. As indicated in the 2005 AISC *Specification* Commentary Section M3.1, "The surface condition of steel framing disclosed by the demolition of long-standing buildings has been found to be unchanged from the time of its erection, except at isolated spots where leakage may have occurred. Even in the presence of leakage, the shop [primer] coat is of minor influence (see page 391, Bigos, Smith, Ball and Foehl, 1954)1." A similar situation exists when steel is fireproofed or in contact with concrete; in fact, paint is best omitted when steel is to be fireproofed because primer decreases its adhesion.

In exterior exposed applications, steel must be protected from corrosion by painting or other means. Likewise, steel must be protected from corrosion in special applications such as the corrosive environment of a paper processing plant or a structure with oceanfront exposure.

The referenced Bigos, Smith, Ball and Foehl article cites a critical relative humidity of 70% and asserts that below this level, steel will not corrode.

I can provide some further back-up for the idea that the relative humidity in an enclosed heated space will be less than 70%. Per the EPA's recommendation, "The ideal levels of humidity for your living space will be less than 60% in the summer and between 25% to 20% in the winter."

It should be noted that there are a number of variables involved. Tullmin (2000) adopts a value of 60% and states: "The critical humidity level is not a constant. It depends on the corroding material, the tendency of corrosion products and surface deposits to absorb moisture and the presence of atmospheric pollutants." So, the guidance applies only to typical buildings. It would not apply to structures subjected to corroding chemicals—some industrial structures, for instance—even if they are enclosed and heated.

In closing, probably the best defense that can be given for the guidance is that it seems to be given worldwide and has stood the test of time. British, Canadian, Australian and European documents seem to provide similar guidance.

Here are the cited references:

- Bigos, J., G.W. Smith, E.F. Ball and P.J. Foehl, 1954, "Shop Paint and Painting Practice," Proceedings of the 1954 AISC National Engineering Conference, AISC, Chicago, IL.
- Tullmin, M. and Roberge, P.R. (2000), "Atmospheric Corrosion," Chapter 18 in *Uhlig's Corrosion Handbook*, 2nd Ed., John Wiley & Sons.

Larry S. Muir, P.E.

Blocking, Chipping and Coping

What is the difference between blocking, chipping and coping?

With the exception of "cope," the terms are informal and their usage may vary. Cope is defined in the *Specification* as: "Cutout made in a structural member to remove a flange and conform to the shape of an intersecting member." In my experience, cope is typically used when the entire width of the flange (and some portion of the web) is removed over some length of the member. Block is used when a portion of the flange (but none of the web) is removed over some length of the member. Cut is obviously a pretty general term.

The 3rd Edition of AISC's *Detailing for Steel Construction* provides the following information in a section titled "Cutting for Clearance," which states:

"Figure 7-28 indicates that the W18×60 and the W21×73 are "flush top"—i.e., the tops are at the same elevation (+98' -6). Therefore, the south end of the W18 must be notched at the top, as shown in Figure 7-32b, to prevent interference with the flange of the W21. Such a notch is called a cope, block or cut. Some shops dimension such cuts while others show a standard cope mark that establishes the required dimensions."

So you can refer to this as a cope, block or cut. "Cut and chip" (or "block and chip") can refer to cutting and then chipping the flange off flush with the web. Chipping refers to the use of a pneumatic chisel to remove steel that projects from the face of the web. Chipping can be expensive and unnecessary. Depending on the connection, you may be able to avoid chipping by using a filler plate on the web to keep the connection clear of any steel that projects beyond the web.

Carlo Lini, P.E.

Oversized Holes and Bearing Connections

The AISC and RCSC specifications do not permit the use of oversized holes in bearing-type connections but do allow short and long slots as long as the slot is perpendicular to the applied load. If the connection is subject to load reversal, this restriction on oversized holes makes sense to me, as it eliminates "slop" in the connection. However, if the connection is supporting a load in a single direction (not subject to load reversal), I do not understand this restriction. Can you please clarify why an oversized hole should not be used in this condition?

You have already stated the AISC *Specification* requirements, and I cannot advise you to violate the *Specification*. However, Section A1 states: "Alternative methods of analysis and design are permitted, provided such alternative methods or criteria are acceptable to the authority having jurisdiction." This allows some latitude.

For the majority of conditions, the *Specification* prohibition on the use of oversized holes in bearing joints makes sense. Even if you had a relatively simple case like a shear connection, the use of the oversized holes could have an impact on the erection tolerances in the *Code of Standard Practice*.

A good case to consider might be a column base plate, where oversized holes are used but the anchors cannot be effectively pretensioned. In this case, AISC generally discourages taking shear in the anchors. When shear is taken in the anchors, we recommend the use of welded washer plates with standard holes. The washer plates eliminate uncertainty about the distribution of force among the anchors. Other industries, and standards, take a different approach. They might neglect some of the anchors entirely or reduce the overall capacity by some factor, presumably based on empirical models.

The primary reason to use oversized holes would seem to be to allow a greater tolerance. The need for a greater tolerance might also indicate uncertainty about achieving bearing at all of the bolts, which in turn might require assumptions about the force distribution.

The distribution of load among the bolts is much clearer with either standard holes or slip-critical joints.

Larry S. Muir, P.E.

Hanging Loads from Existing Holes

The situation I'm currently addressing has only one bolt, so the load distribution is not a concern. The condition involves hanging loads from existing holes. The diameter of the hole is 1⅝ in., so there is no bolt for which this hole would be considered "standard." Since the 1⅝-in. hole is only slightly oversize for a 1½-in. bolt, it seemed reasonable to allow it. However, the *Specification* seems to prohibit this condition. I would like to make an informed decision based on my own judgment relative to this condition. Do you have any further thoughts given this additional information?

I would tend to treat your situation as one that is not considered by the *Specification* as opposed to one that is specifically prohibited. Ultimately, you have to use your own judgment. I will provide some thoughts.

One difference between a single bolted connection and a pin is related to the increased clamping provided by the bolt (even a snug-tight bolt) as compared to a pin. I am assuming you have a bolted connection in this respect. The *Specification* provides different bearing equations for pin-connected joints versus bolted joints.

Another consideration might be relative movement of the parts under load. Section D5.2 of the *Specification* states: "When the pin is expected to provide for relative movement between connected parts while under full load, the diameter of the pin hole shall not be more than 1⁄32 in. (1 mm) greater than the diameter of the pin." In order to understand this requirement you might want to refer to (Johnston, 1939) cited in the Commentary. I will assume you do not have relative movement of the parts under load.

If the assumptions stated above are correct, then I have good news for you. The 2016 *Specification*, which will be published later this year, will give the standard hole diameter for bolts 1 in. and greater as the bolt diameter plus ⅛ in.

Larry S. Muir, P.E.

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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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