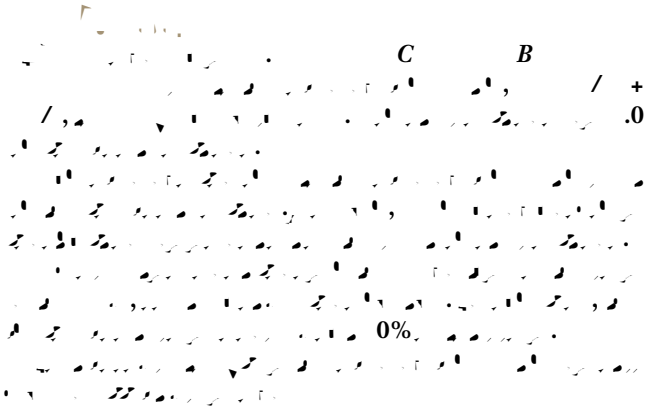
If you've ever asked yourself "Why?" about something related to structural steel design or construction, *Mode n S eel*'s monthly Steel Interchange is for you! Send your questions or comments to .

steel interchange



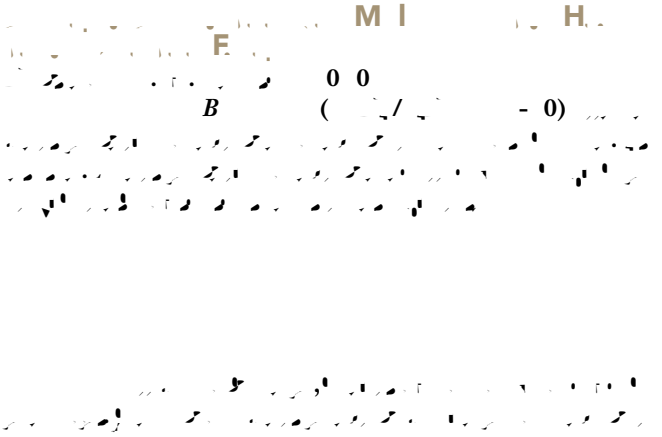
Yes. AISC design guides (available at) provide guidance, not requirements. The guidance is intended to be useful to practicing engineers during typical designs. In order to provide simple and practical guidance, the procedures are sometimes simplified and conservative, as you note. Other approaches are possible. The references in the design guides often provide more in-depth discussions of the issues and can be helpful when addressing unusual conditions.

In this case, Section 5.7.2 of Design Guide 2 provides the following additional information regarding web buckling:

> "The criteria to prevent web buckling are based on the work of Redwood and Uenoya (1979) in which they developed conservative criteria based on the opening size and shape and the slenderness of the web of the member…
>
> Their recommendations are adopted in whole for steel members and relaxed slightly for composite sections to account for the portion of the shear carried by the concrete slab, V_c, The higher limit on the opening parameter, p_o, of 6.0 for composite sections versus 5.6 for steel sections coincides with successful tests (Donahey and Darwin 1988). Failure in composite sections is normally governed by failure of the concrete slab, and adequate strength has been obtained even when local buckling has been observed (Clawson and Darwin 1980, Clawson and Darwin 1982, Donahey and Darwin 1986). As discussed in section 5.6 (after Eq. 5-20), the limits on also serve to ensure that the design equations provide conservative predictions for member shear strength, even if web buckling is not a factor.
>
> …The guidelines limiting the maximum values of V_m can be quite conservative for sections with web width-thickness ratios below the maximum limits. Redwood and Uenoya (1979) provide guidance for members which lie outside the limits of this section."

In addition, a reference to Lucas and Darwin 1990 in the design guide summarizes the results of a number of physical tests. At least a couple of these had opening parameters in excess of the limit provided in the design guide and still resulted in test-to-predicted strengths in excess of one.

Ca lo Lini, PE



Your question contains an incorrect assumption. It has been shown through physical tests that within certain limits, a member with holes can still develop its gross flexural strength. Section F13.1 of the *Specifica ion fo S c al S eel B ilding* (ANSI/AISC 360, available at) addresses "Strength Reductions for Members with Holes in the Tension Flange." In this section, when F

$A_{fn} \geq Y F A_{fg}$ the limit state of tensile rupture does not apply. For capacity-based design, this relationship would have to be adjusted to account for R

No. We are not surprised that some fabricators prefer TC bolts. TC bolts can be used in slip-critical, snug-tight and pretensioned connections. The bolts also have other potential advantages that have made them attractive to fabricators and erectors. The 2014 RCSC *Specifica ion fo S c al join U ing High-S eng h Bol* (available at) does not limit the amount of pretension in a bolt. Therefore, a TC bolt can be tensioned up to the point where the spline is severed, even in a connection specified as snug-tight and designed as a bearing connection. However, simply severing the spline does not ensure that the joint has been properly pretensioned.

The installation of pretensioned joints involves the following considerations beyond those for a snug-tight joint:

- . Section 8.2 of the RCSC *Specifica ion* states: "Pre-installation testing shall be performed for each fastener assembly lot prior to the use of that assembly lot in the work. The testing shall be done at the start of the work."

  This is an extra step that must be performed during the bolt installation for pretenstioned connections but is not required for snug-tight conditions. Though pre-installation verification is a relatively straightforward process, we do occasionally hear of issues. At the very least, it involves having a properly calibrated tension calibrator (though not all fabricators, erectors and inspectors have one on hand), scheduling the testing and ordering bolts in sufficient quantities to accommodate both the installation and the required testing.
- . Section 2.2 of the RCSC *Specifica ion* addresses the storage of fastener components. These requirements apply equally to snug-tight and pretensioned installations. However, the condition of the bolt and the lubricant is more of a concern for pretensioned joints. TC bolts can be particularly sensitive to the condition of the lubricant. If the bolts are not properly stored or the final tensioning is delayed, then the bolts may need to be cleaned and relubricated. For heavy hex head bolts (Grade A325 and A490) this can be done by the user in the field. TC bolts "shall not be relubricated, except by the manufacturer."
- . You cannot simply put a TC bolt in a hole and engage the wrench until the spline breaks and expect to have a properly pretensioned joint. First, the bolts must be installed in accordance with the requirements in Section 8.1 of the RCSC *Specifica ion*, which lists the installation requirements for snug-tightened joints. For large, heavy joints, you may actually end up breaking bolts or the splice before you bring the plies into firm contact, and the RCSC *Specifica ion* addresses this, stating: "If a splined end is severed during this operation, the fastener assembly shall be removed and replaced." Once firm contact is achieved, the installation must progress "systematically from the most rigid part of the joint in a manner that will minimize relaxation of previously pretensioned bolts."
- . There are inspection tasks required for pretensioned connections that are not required for snug-tight connections. Section N5.6.(a) of the AISC *Specifica ion* states: "For snug-tight joints, pre-installation verification testing as specified in Table N5.6-1 and monitoring of the installation procedures as specified in Table N5.6-2 are not applicable.
- . Arbitration is addressed in Section 10 of the RCSC *Specifica ion* and ideally, will rarely be required. Allowing snug-tight installation eliminates the possibility that it will be required.

Each of the above items involves logistical considerations and present potential impacts to the cost and schedule of the project. Some of these items are less of a concern in the shop than they are in field. However, many bolted joints are installed in the field. Therefore, the preferences of the erector must also be considered.

La S. M i , PE, and Ca lo Lini, PE