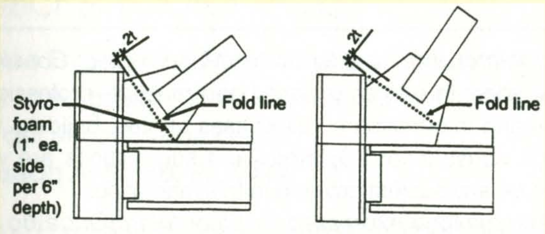
If you've ever asked yourself "why" about something related to structural steel design or construction, *Modern Steel Construction's* monthly *Steel Interchange* column is for you!

Gusset Plate Yield Line

We are currently detailing our first Special Concentric Braced Frame (SCBF) in Seismic Design Category D and have a question. We understand the concept of creating a yield line through the gusset plate. Our issue concerns the column base at the floor slab. The gusset plate will need to be huge to establish the yield line above the concrete slab because the slab would confine the brace and gusset, preventing the yield zone from forming. The best idea we can come up with is to wrap the gusset and brace end with a layer of compressible material such as rigid insulation prior to pouring concrete. Is this something that has been discussed or written about already? Does our idea seem reasonable? We are assuming that slab confinement is an issue here and would like to know if it is typically dealt with or simply ignored.

Question sent to AISC's Steel Solutions Center

One can either design a larger gusset plate to achieve a proper Whitmore width (i.e. fold line), or alternatively one can use compressible filler on each side of the gusset that will be formed around the plate in the concrete slab. This is a common solution which is discussed in the AISC Continuing Education Seminar, "Seismic Braced Frames: Design Concepts and Connections." The detail in the seminar, below, shows 1" foam on each side of the gusset plate for a 6" depth into the slab.



Detail from the AISC seminar "Seismic Braced Frames: Design Concepts and Connections."

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Anchor Embedment Length

Is there a standard chart to indicate the average embedded length for bent rod anchor rods?

Question sent to AISC's Steel Solutions Center

The AISC *Specification* does not cover the subject of anchor rod embedment lengths and has no charts to indicate what these embedments should be. We are not familiar with any current publications that provide such information for anchor rods.

The AISC *Specification* does make reference to ACI 318, Appendix D for anchorage into plain concrete. Alternatively, the main provisions of ACI 318 can be used when anchor rod forces are transferred into the reinforcement in reinforced concrete. The embedment length is a function of the design loads on the anchor rod and is therefore not a universal measurement lengthwise. Typically, if the rod must resist tensile forces, it is recommended to use embedded nuts to resist the pullout, as bent rods have limited capacity in that regard. As a reminder, ASTM F1554 is the AISC-recommended material for anchor rods.

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Use of Shims

I am going to use oversized holes in flange-plated moment connections to a column utilizing slip-critical bolts. I would like to allow the erectors some leeway by letting them use shim plates between the flange plates and beam flanges. My questions are:

1. **Should shims be utilized at both the top flange and the bottom flange simultaneously, or just at either the top or bottom?**
2. **What is the suggested maximum shim thickness? Can I just use that shown in Figure 3-4c on page 3-8 of the ASD 9th Edition *Connections Manual*?**
3. **Is there a minimum shim thickness?**
4. **Based on that shown on page 3-12 of the *Connections Manual*, is it correct to assume that either conventional or finger shims are permitted, even if the bolts are slip-critical in oversized flange plate holes?**

Question sent to AISC's Steel Solutions Center

1. Good thinking to provide for erection tolerances. If the beam is detailed and fabricated off the bottom flange location, the shims can likely be placed at only the top flange, which is the easiest location for the erector to access. In this manner they are not fighting gravity in trying to insert the shims. You will find some suggested details in the AISC *ASD Manual of Steel Construction*, 9th Edition, page 4-127.
2. Section J5 of the 2005 AISC *Specification* (**www.aisc.org/2005spec**) covers the use of fillers (shims). When the joint is made slip-critical per option four in that section (which has slip prevented up to the design strength, not just as a serviceability limit state), there is no limit on thickness. Otherwise (including when the joint is slip-critical and only design for slip resistance as a serviceability limit state), options one, two, or three must be used.

   In option one, if possible, limit the shimming to ¼" to avoid the development requirement or reduced connection capacities stipulated in the *Specification*. The figures referenced in the ASD 9th Edition *Connections Manual* are based on tolerance issues rather than connection capacities, and are good recommendations to follow for that purpose.
3. The minimum shim thickness is that required to satisfy erection tolerances. A practical limit for a minimum shim thickness is 1/16".

4. Yes, either conventional or finger shims can be used. A text reference is Section 3.2.2 of the RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts* (a free download at www.boltcouncil.org).

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Bending of Tee Sections

Please provide guidance on how to calculate the allowable bending strength for tee sections. We are assuming that when the flange is in compression, the member can be treated as an I-shaped beam. What about when the stem is in compression or when the beam is subjected to weak axis bending?

Question sent to AISC's Steel Solutions Center

Flexural design requirements for strong-axis bending of tees are found in Section F9 of the 2005 AISC *Specification* (www.aisc.org/2005spec). One can check either case of the tee stem in tension or compression. In addition, Section F9 checks for stability by way of lateral-torsional buckling and flange local buckling checks.

For weak-axis bending of the tee, nothing has been published or tested to my knowledge. However, it probably can be treated as a plate (i.e. the flange) under strong-axis bending. The stem will be at the neutral axis, so it provides little additional flexural capacity. The stem location may add some resistance to lateral-torsional buckling, but not very much (refer to Appendix 6 of the 2005 AISC *Specification* for stability bracing requirements). Essentially, it is a poor torsional brace. In practical terms, the configuration would be best described as a plate under strong-axis bending.

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ϕ Factors for Base Plates

The ACI ϕ-factor for LRFD bearing is 0.65 while AISC allows 0.60. Which factor is an engineer supposed to use?

Question sent to the AISC's Steel Solutions Center

We realize this conflict exists. The background of the conflict occurred because the load factors ACI previously used for concrete design (1.4DL + 1.7LL) utilized a ϕ-factor of 0.70 for bearing on concrete. When ASCE 7 introduced load factors (1.2DL + 1.6LL), this was the basis of the AISC *LRFD Specification*. AISC elected to use a ϕ-factor of 0.60 for the bearing on concrete. The 2002 ACI 318 basic approach adopted the ASCE 7 load factors (1.2DL + 1.6LL) and modified the ϕ-factor for bearing on concrete to 0.65 for use with these factors. Note that a joint AISC/ACI committee is working in collaboration to resolve such variances.

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Anchor Rod Grades

An engineer has specified ASTM A325 hooked anchor rods for a project. Would it be acceptable to use ASTM F1554, Gr. 105 hooked anchor rods as a substitute?

Question sent to the AISC's Steel Solutions Center:

My first question in return is: How are you going to bend those short "bolts"? The second question is: Why are ASTM A325 bolts being used as anchor rods? (A325s typically are available in maximum lengths of 10" or less.) These are really questions for the EOR because the EOR needs to learn that A325 has been incorrectly specified here.

ASTM A325 fasteners are high strength bolts intended for use in steel-to-steel connections. As such, the installation is required to follow the stipulations of the RCSC *Specification for Structural Joints Using ASTM A325 or A490 Bolts*. See Section A3.4 of the 2005 AISC *Specification* (www.aisc.org/2005spec) for a listing of approved anchor rod materials. ASTM F1554 is the preferred material specification for anchor rods.

Much of base anchorage design is intricately tied to the embedment and concrete limitations, which is addressed for anchorage into plain concrete in ACI 318, Appendix D. Decisions as to materials that can be used or substituted are based on the project requirements, and are appropriately made by the project EOR.

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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 to 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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