

Modern Steel Construction's monthly *Steel Quiz* allows you to test your knowledge of steel design and construction. All references to LRFD specifications pertain to the 1999 *LRFD Specification for Structural Steel Buildings*, available as a free download from AISC's web site:

www.aisc.org/lrfdspec

ASD references pertain to the 1989 ASD Specification for *Structural Steel Buildings*. Where appropriate, other industry standards are also referenced.

Anyone is welcome to submit questions for Steel Quiz—one question or 10! If you or your firm are interested in submitting a Steel Quiz question or column, contact ►

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This month's Steel Quiz was developed by the staff of AISC's Steel Solutions Center. Sharpen your pencils and go!

- 1. True/False:** Snug-tightened and pretensioned bolted joints are known as bearing joints.
- 2. True/False:** Slip-critical bolted joints must always be pretensioned to a minimum installation tension.
- 3.** What is the definition of undercut?
 - a. a cut or series of cuts to the inside faces of a flange and a portion of the web
 - b. a notch resulting from the melting and removal of base metal at the edges of a weld
 - c. the first phase of a two phase cutting procedure for making weld access holes
 - d. the preparation of beveled flange joints for PJP and CJP groove welds
- 4.** How are welded studs tested in the field?
 - a. bend test
 - b. torque test
 - c. tension test
 - d. shear test
- 5.** What is the minimum interstory drift angle that connections in Special Moment Frames (SMF) are required to sustain according to the 2002 AISC *Seismic Provisions*?
 - a. 0.01 radians
 - b. 0.02 radians
 - c. 0.03 radians
 - d. 0.04 radians
- 6.** What solutions may be appropriate to remediate a column that is fabricated short?
 - a. increase base plate thickness
 - b. shim or grout to proper height
 - c. splice the column
 - d. modify beam connections to correct elevation
- 7. True/False:** Residual stresses are independent of cross-sectional shape and dimensions.
- 8.** Proper design of a beam brace mandates the consideration of:
 - a. brace strength
 - b. brace stiffness
 - c. brace spacing
 - d. all of the above
- 9.** Are K-braces allowed in Special Centrically Braced Frames (SCBF)? What about for Ordinary Centrically Braced Frames (OCBF)?
- 10.** Should second-order effects be considered in the design of frames?

Turn page for answers

Answers

1. True. Snug-tightened and pretensioned joints are known as bearing joints. Such joints are designed to slip and bear against the edge of the bolt hole under service loads. At the other end of the spectrum are slip-critical joints. Unlike bearing joints, they are design not to slip under service load. It is important to realize that in the event that the service load is exceeded, a slip-critical joint may slip into bearing. To avoid bearing failures, the 2004 *RCSC Bolt Specification* (a free download from www.boltcouncil.org) requires all slip-critical joints to be checked for bearing.

2. True. Like pretension joints, slip-critical joints must be installed at a minimum pretension of $0.70F_u$ of the fastener. Slip-critical joints require that the faying surfaces be prepared to a specified slip class (i.e. each class pertains a mean slip coefficient value). In this manner, the slip resistance of the faying surfaces is incorporated into the design strength calculations.

3. The answer is **b**. Undercut is a notch resulting from the melting and removal of base metal at the edges of a weld.

4. The answers are **a**, **b**, and **c**. Either the bend, torque, or tension test can be used to test shear studs. Refer to AWS D1.1:2004 Section 7.6.6. for additional information.

5. The answer is **d**, 0.04 radians, according to Section 9.2(a) of the 2002 AISC *Seismic Provisions* (a free download from www.aisc.org/seismic). It should be noted that this value for SMF is essentially identical to that contained in the 1997 AISC *Seismic Provisions*, which required an inelastic rotation of 0.03 radians. The interstory drift angle is approximately 0.01 radians larger than the inelastic rotation. That is, the elastic portion of frame drift is approximately 0.01 radians.

6. The practical answers are **b**, **c**, and **d**. Increasing the base plate thickness would be an impractical field fix for short columns. For additional solutions to common field problems, be sure to attend AISC's "Field Fixes: Common Problems in Design, Fabrication, and Erection—Solutions and Prevention" seminar at a city near you. Visit www.aisc.org and click on the "Learning

Opportunities" link for seminar information and schedule.

7. False. Residual stresses are developed due to the uneven cooling rates, which are a direct product of cross-sectional shape and thickness. Flange toes and web centers will cool faster than other parts of the cross-section, and thicker parts are slower to cool than thinner elements.

8. The answer is **d**, all of the above. Brace strength has traditionally been the most common check for beam stability (i.e. the 2% rule). However, as outlined in Chapter C of the 1999 AISC *LRFD Specification*, brace stiffness and unbraced beam length (i.e. brace spacing) also play an important role.

9. K-bracing is not permitted for SCBF per Section 13.4b of the 2002 AISC *Seismic Provisions* for SCBF systems. It is considered undesirable to have columns that are subjected to unbalanced lateral forces associated with K-brace systems. K-bracing can be used in OCBFs, which have less stringent performance requirements.

10. Yes. Section C1 of the 1999 AISC *LRFD Specification* states that second-order effects shall be considered in the design of frames. Those using the 1989 AISC *ASD Specification* should refer to Commentary Section H1, which discusses the incorporation of a second-order moment amplification factor in the combined stresses expression for axial compression and bending, which are typical forces in frames. Please note that the beneficial effect of second-order axial tension is usually ignored. ★

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