steel quiz

LOOKING FOR A CHALLENGE? *Modern Steel Construction*'s monthly Steel Quiz tests your knowledge of steel design and construction. Most answers can be found in the 2005 *Specification for Structural Steel Buildings*, available as a free download from AISC's web site, **www.aisc.org/2005spec**. Where appropriate, other industry standards are also referenced.

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

1 Which bolted joint type is not permitted by the AISC and RCSC specifications?

a. finger-tightened
b. snug-tightened
c. pretensioned
d. slip-critical

2 How can local buckling be avoided?

3 If the nominal strength is R_n (kips), what are the design strength (LRFD) and allowable strength (ASD), respectively:

a. ΩR_n, ϕR_n
b. ΩR_n, R_n/ϕ
c. ϕR_n, ΩR_n
d. ϕR_n, R_n/Ω

4 **True/False.** Structural steel shapes and plate can be made to ASTM A992.

5 Can eccentricity be ignored in the design of single-plate shear connections?

6 What is prying action?

7 **True/False.** It is recommended that ASTM A325/A490 high-strength bolts not be welded.

8 Which of the following seismic load resisting systems does not require conformance demonstration for moment connections?

a. SMF, IMF, OMF
b. SMF
c. IMF
d. OMF

9 The limitations for the maximum size of fillet welds found in the AISC specification address the:

a. tendency of the thicker part joined to act as a heat sink; weld cracking concerns
b. burn-through of the thinner part joined
c. melting of the corner; actual weld throat smaller than anticipated
d. potential for warping of the base metal

10 Which three limit states are used in the flexural design of an unsymmetric shape?

a. yielding, lateral-torsional buckling and local buckling
b. yielding, lateral-torsional buckling and torsion
c. yielding, flexural-torsional buckling and local buckling
d. yielding, flexural-torsional buckling and torsion

TURN PAGE FOR ANSWERS

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ANSWERS

1 The answer is **a**. Section J3.1 of the 2005 AISC specification (**www.aisc.org/2005spec**) discusses bearing (snug-tightened and pretensioned) joints and slip-critical joints. Chapter 4 of the 2004 RCSC specification (**www.boltcouncil.org**) outlines snug-tightened, pretensioned, and slip-critical as the three bolted joint types that may be specified by the engineer of record. Hence, a finger-tightened joint is not an acceptable bolted joint per the specifications.

2 Local buckling can be avoided by using compact sections. A compact section is defined in the 2005 AISC specification as a section capable of developing a fully plastic stress distribution and possessing a rotation capacity (ratio of inelastic rotation to idealized elastic rotation at first yield) of approximately 3 before the onset of local buckling. Similar criteria with more stringent width-thickness limitations are given for high-seismic design in the 2005 AISC *Seismic Provisions*.

3 The answer is **d**. The design strength used in LRFD is ϕR_n (kips) or ϕM_n (k-ft). The allowable strength used in ASD is R_n/Ω (kips) or M_n/Ω (k-ft). Note that the entire 2005 AISC specification is based on the same set of nominal strength expressions, such as R_n and M_n. The values for ϕ and Ω are listed for each limit state considered in the various chapters of the AISC specification. In all cases, $\Omega = 1.5/\phi$.

4 **Both true and false**. **True**, because W-shapes today are most commonly made to ASTM A992. Although no other shape is yet commonly available in ASTM A992 material, the standard (**www.astm.org**) is written to include other rolled steel structural shapes for use in building frames or bridges, or for general structural purposes. **False**, because plates are not included in the ASTM A992 standard. If plate of equivalent yield strength is desired, it can be specified as ASTM A572 Grade 50.

5 **Yes**, as follows when the conventional procedure included in the 13th Edition AISC *Steel Construction Manual* is used. "Conventional" is defined for these connections as containing only a single row of bolts, and the number of bolts in the connection, *n*, is limited to 2 to 12. The distance from the bolt line to the weld line, *a*, must be equal to or less than 3.5". If the conventional connection contains short slotted holes, eccentricity can be ignored for up to *n* = 12. If standard holes are used, eccentricity can be ignored for *n* = 2 to 9 bolts; but must be considered for 10 to 12 bolts. When the dimensional and other limitations of conventional single-plate shear connections cannot be satisfied, this connection is designed using the alternative procedure provided for the "extended configuration." Eccentricity must be considered in the design of "extended" single-plate shear connections.

6 Prying action is the amplification of the tension force in a bolt caused by the leverage between the point of applied load, the bolt, and the reaction of the connected elements. It is important to recognize that prying action results from fitting flexibility, even though its primary impact is on the bolts through that fitting. Prying action can be reduced, when required, by increasing the fitting thickness.

7 **True.** ASTM A325 and A490 bolts are made from high-strength steel and normally have a high carbon equivalency. In addition, all are heat-treated. The effect of heat from welding to these fastener components can lead to reduction of strength and cracking. Thus, it is generally recommended that high-strength bolts should not be welded.

8 The answer is **d**. Referring to Section 11 of the 2005 AISC *Seismic Provisions* (**www.aisc.org/2005seismic**), ordinary moment frames (OMF) do not require conformance demonstration because the detail used is a prescriptive detail that is already known to satisfy the associated requirements. That is, one does not need to qualify (test) or use prequalified moment connections with OMFs. The prescriptive details for OMF moment connections are provided in Section 11 of the AISC *Seismic Provisions*.

9 The answer is **c**. One can visualize that applying a fillet weld to a lap joint may result in difficulty when attempting to identify the original edge of the plate where the weld was applied if the plate edge is melted through the full thickness during the welding process. If the edge is melted, it is difficult if not impossible to determine the actual throat distance, and the actual throat distance can be much smaller than the apparent throat distance. The maximum fillet weld size specifed in Section J2.2b in the 2005 AISC specification generally limits the weld size to 1/16" less than the thickness so the actual corner of the edge can be confirmed. Plates thinner than ¼" are exempted from this limitation because the concern does not apply below this thickness.

10 The answer is **a**. That is, one must design for the lowest value obtained from the limit states of yielding, lateral-torsional buckling, and local buckling—just like for most other flexural member cases. Note, however, that the critical buckling stress for lateral-torsional and local buckling of unsymmetric shapes generally must be determined by analysis. Refer to Section F12 of the 2005 AISC specification for additional information. Incidentally, the limit state of flexural-torsional buckling (a tempting option in the list of answers) applies only to certain compression members.

Anyone is welcome to submit questions for Steel Quiz. If you are interested in submitting one question or an entire quiz, contact AISC's Steel Solutions Center at 866.ASK.AISC or at **solutions@aisc.org**.

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