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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Sharpen your pencils. Get ready, get set, go!

1. Are ASTM A449 bolts permitted in bearing connections with bolt diameters greater than 1½"?

2. Why are there restrictions when using ASTM A449 bolts in steel-to-steel connections?

3. Which AWS standard addresses weld symbols?

4. How does one determine the effective throat thickness of flare groove welds?

5. Are flexible moment connections (FMC) designed differently than PR connections?

6. Can you design any flange-connected moment connection as a flexible moment connection?

7. Is it necessary to provide a uniform bearing surface underneath column base plates designed according to the AISC design criteria?

8. Are base-plate holes sizes the same as the oversized hole sizes listed in Chapter J of the AISC *Specification*?

9. Do you need to use the AISC *Seismic Provisions* for seismic load resisting systems listed as $R > 3$ in the model building codes? What is the significance of R?

10. What are the differences between lateral-torsional and flexural-torsional buckling?

Turn page for answers

Answers

1. Yes. According to Section A3 of the 1999 *LRFD Specification*, ASTM A449 bolts are not permitted to be used in slip-critical connections nor in any diameter less than or equal to 1½" (ASTM A325 bolts are available up to 1½" diameter.)

2. While ASTM A449 seems to offer the same strength as ASTM A325, the use of A449 material is restricted in Section A3 of the 1999 *LRFD Specification.* This is because A449 bolts are not produced to the same inspection and quality assurance requirements as ASTM A325 bolts. Also, A449 bolts are not produced to the same heavy-hex head dimensions as A325 bolts.

3. *AWS A2.4: Standard Symbols for Welding, Brazing, and Nondestructive Examination*.

4. The effective throat thickness of flare bevel groove and flare V-groove welds is listed in Table J2.2 of the 1999 *LRFD Specification*. Also, refer to Table 2.1 of the *AWS D1.1:2002 Structural Welding Code*.

5. Yes. The design of flexible moment connections (FMC), also known as wind connections, are based upon several important yet simplified assumptions:
   a. The lateral frames must resist the lateral moments throughout the entire structure from top to bottom,
   b. The beams, columns, and their connections must resist the applied bending moments,
   c. The girders must be capable of carrying the full gravity load as simply supported beams,
   d. The connection material must have sufficient inelastic rotation capacity to prevent the welds and/or fasteners from failing due to combined gravity and lateral loading.

   None of the above assumptions account for the level of restraint in the connection. The design of PR connections involves a known moment-rotation diagram (including shakedown behavior effects) for a specific PR connection, typically obtained from testing. Hence, the level of restraint and lifetime performance characteristics in the PR connections must be known.

6. No. The AISC *Manual* has design procedures for two types of flexible moment connections (FMC), namely the flange-angle and flange-plated flexible moment connections. Refer to the 3rd Edition *LRFD Manual* (page 11-3) for additional information. Other configurations are possible, though some mechanism must be present to allow for the deformations necessary in the assumed behavior.

7. Yes, though the bearing joint gap provision in the *LRFD Specification* Section M4.4 is reasonable for gaps between the plate and grout. The basis of all AISC base-plate design models (i.e. axial compression or bending moment on the base plate) assumes that grout or some other uniform bearing surface is provided. The 3rd Edition *LRFD Manual* states "the column base plate is then assumed to distribute the column axial force to the concrete or masonry as a uniform bearing pressure by cantilevered bending of the plate." A similar assumption is used in AISC *Design Guide 1: Column Base Plates* (available from e-Pubs or the AISC bookstore at **www.aisc.org/bookstore**.)

8. No. Base-plate holes sizes are normally larger than the oversized hole sizes specified in Chapter J, which apply specifically to steel-to-steel bolted assemblies. For column anchorages, recommended base-plate hole sizes are larger to compensate for the misalignments in anchor-rod foundation locations. The nominal hole sizes for base plates can be found in Table 14-2 of the 3rd Edition *LRFD Manual*.

9. Yes. It is important to note that the Seismic Response Modification Factor, *R*, is a measure of the level of ductility inherent to a seismic load-resisting system. The AISC *Seismic Provisions* must be used for seismic load-resisting systems requiring high ductility ($R > 3$), achieved by special seismic detailing requirements. For systems of normal ductility ($R = 3$), the AISC *Seismic Provisions* need not be applied.

10. Lateral-torsional buckling is a bending limit state in doubly, singly and unsymmetric sections loaded about the member's strong-axis. This limit state is the combined twisting and strong-axis flexural buckling of an unrestrained compression flange. Flexural-torsional buckling is an axial compression limit state that mostly occurs in singly and unsymmetric compression members. It is the simultaneous bending and twisting of a member and can occur in channels, structural tees, double-angle shapes, and equal-leg single angles. ★