

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 quiz was developed by Kurt Gustafson, P.E., S.E., AISC's Director of Technical Assistance. Sharpen your pencils and go!

1. In terms of slip resistance of slip-critical bolted joints, what is a Class C slip resistance?

2. When are pretensioned joints required in the AISC and RCSC specifications?

3. Why are compressible materials prohibited in connected plies of bolted parts?

4. Are paint, hot-dipped galvanized coatings and zinc-based coatings considered compressible materials?

5. Does the 2% rule for beam lateral bracing account for bracing stiffness?

6. In high-seismic design, are bolts allowed to share load in combination with welds on the same faying surface?

7. **True/False:** Cables used for permanent bracing or suspension of systems are not considered structural steel.

8. What diameter hole is currently recommended in a base plate for a 1" diameter anchor rod?

- a. $1\frac{1}{16}$ "
- b. $1\frac{5}{16}$ "
- c. $1\frac{9}{16}$ "
- d. $1\frac{13}{16}$ "
- e. $1\frac{15}{16}$ "

9. **True/False:** Base shear in a column must be transferred through the anchor rods from the base plate to the foundation.

10. What is the minimum spacing for bolt holes in relation to the diameter of the bolt in a row of fasteners?

- a. $2d$
- b. $2\frac{1}{2}d$
- c. $2\frac{2}{3}d$
- d. $3d$
- e. $3\frac{1}{2}d$

Turn page for answers

Answers

1. According to the 2000 RCSC *Bolt Specification* (a free download from www.boltcouncil.org), when prepared by hand wire brushing, a roughened hot-dipped galvanized faying surface is designated as Class C for design. Such a surface has a mean slip coefficient of 0.35.

2. In the 1999 *LRFD Specification*, Section J1.11 states that pretensioned high-strength bolts (or welds) shall be used for the following connections:

- Column splices in all tier structures 200 feet or more in height.
- Column splices in tier structures 100 to 200 feet in height, if the least horizontal dimension is less than 40% of the height.
- Column splices in tier structures less than 100 feet in height, if the least horizontal dimension is less than 25% of the height.
- Connections of all beams and girders to columns and of any other beams and girders on which the bracing of columns is dependent, in structures over 125 feet in height.
- In all structures carrying cranes of over five-ton capacity: roof-truss splices and connections of trusses to columns, column splices, column bracing, knee braces and crane supports.
- Connections for supports of running machinery, or of other live loads which produce impact or reversal of stress.
- Any other connections stipulated on the design drawings.

The 2000 RCSC *Bolt Specification*, Section 4.2 requires pretensioned high-strength bolts for:

- Joints in which fastener pretension is required in the specification or code that invokes the specification.
- Joints that are subject to significant load reversal.
- Joints that are subject to fatigue load with no reversal of the loading direction.
- Joints with ASTM A325 or F1852 bolts that are subject to tensile fatigue.
- Joints with ASTM A490 bolts that are subject to tension or combined

shear and tension, with or without fatigue.

Additional information is available in the *RCSC Specification* for when a slip-critical joint is required.

3. Compressible materials can prevent proper snug-tightening and pretensioning, when required, from being achieved during installation of high-strength bolts. A compressible element also creates a service condition different than that assumed in the AISC and RCSC specifications. As mentioned in Section 3.1 of the 2000 RCSC *Bolt Specification*, compressible materials (gaskets, insulation or any compressible materials) shall not be placed within the grip of the bolt.

4. Paint, hot-dipped galvanized coatings and cold zinc coatings are not considered compressible materials and can be readily used with pretensioned and slip-critical bolted joints. Refer to the 2000 RCSC *Bolt Specification*.

5. No, it does not, as it only considers strength. This long-standing rule of thumb provides bracing for two percent of the compressive force in the flange or member being braced. Although it lacks an explicit consideration of the required bracing stiffness, this approximation is typically conservative when used with proper brace and connection details (that is, details that have appropriate stiffness characteristics). Note that the two percent rule applies only to compression members that are considered straight within ASTM tolerances. A task committee of the AISC Committee on Specifications developed specific strength and stiffness criteria for beam bracing, which are included in Section C3 of the 1999 AISC *LRFD Specification*. Additional information on this and other bracing topics can be found in:

- Yura, J.A. and T.A. Helwig, 2001, Lecture notes for SSRC/AISC seminar "Bracing for Stability," AISC, Chicago.
- Yura, J.A., 2001, "Fundamentals of Beam Bracing," *Engineering Journal*, Vol. 38, No. 1, (1st Quarter), pp. 11-26, AISC, Chicago.

6. No. Refer to the 2002 AISC *Seismic Provisions* Section 7.2.

7. True. Cables for permanent bracing (i.e. tension-only bracing) or suspension systems are considered other steel, iron or metal items per Section 2.2 of the 2000 AISC *Code of Standard Practice*.

8. d. $1\frac{13}{16}$ inch diameter. The current recommendations for anchor rod holes in base plates are listed in Table 14-2 of the 3rd edition *LRFD Manual*. These hole sizes have been increased from the earlier ASD editions to provide for better harmonization with actual performance of other trades in setting anchor rods.

9. False. If there is net compressive force between the base plate and foundation, some, if not all of the base shear can be transferred through friction. When the friction force is not adequate to resist this base shear, some other adequate means of transferring the shear such as shear lugs, retaining clips or the anchor rods themselves must be employed. Remember, the holes in the base plate for the anchor rods are likely extra-oversized (see question 8). Therefore, if the anchor rods are to be relied on for shear transfer, a detail must be employed to accommodate the required transfer of force.

10. c. $2\frac{2}{3}d$. This is the minimum spacing, although a distance of $3d$ is preferred as discussed in Section J3.3 of the 1999 *LRFD Specification*. Note that the spacing may have to be increased when checking bearing strength at bolt holes per Section J3.10 to provide a clear distance that will facilitate the required nominal strength. ★

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