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 the AISC Steel Solutions Center. Put on your thinking cap!

1. **True/False:** Some inelastic but self-limiting deformation is permissible for simple shear connections to accommodate end rotations of simple beams.

2. How does one approximate the torsional constant, J, for open cross-sections such as those found in wide-flanges, channels and angles?

3. How can one quickly calculate the principal moments of inertia I_w and I_z of single-angles?

4. Can the use of concrete fill provide the required fire protection for HSS columns?

5. When a wide-flange shape cools after rolling at the mill, which regions in the cross-section develop tensile residual stress?

6. Why are ASTM A325 and A490 high-strength bolts typically characterized by their ultimate tensile strengths rather than their yield strengths?

7. What is meant by the terms weak and strong positions for stud placement in composite construction?

8. **True/False:** Complete-joint-penetration (CJP) groove weld design strength is determined by the base-metal yield strength.

9. When calculating the local web yielding strength for a wide-flange shape, should you use the $k_{detailing}$ or k_{design} value found in the 3rd edition *LRFD Manual* properties tables?

10. If the fabricator is responsible for selecting or completing connection details, must the structural design drawings contain load data information?

Turn page for answers

Answers

1. True. Refer to Section J1.2 on Simple Connections in the 1999 *LRFD Specification* (a free download from **www.aisc.org/lrfdspec**.)

2. One can define several rectangular elements within an open cross-section (i.e. an angle contains two, whereas a channel contains three rectangular elements.) The torsional constant for each element is simply $bt^3/3$. Summing the torsional constants for each element comprising an open cross-section will result in the torsional constant for the entire cross-section. Please note that fillet radii have a small contribution and are ignored in this approximate approach.

3. Using the 3rd edition *LRFD Manual*, the value of r_z can be found in the single-angle properties table along with values of I_x and I_y. By definition, one can determine $I_z = Ar_z^2$. By using the identity $I_x + I_y = I_w + I_z$, the value of I_w is also easily determined.

4. Yes. Refer to AISC FAQ 11.2.6 at **www.aisc.org/faq**. A copy of this particular FAQ follows:

How do concrete- or water-filled tubular steel columns perform in a fire?

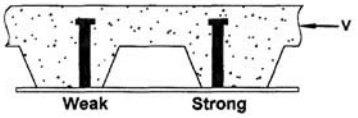
Water or concrete inside tubular steel members act as "heat sinks," thereby reducing temperature rise in the steel and significantly enhancing fire resistance. In the case of the concrete filled tubular columns, the concrete will also contribute to the load-bearing capacity when the outside steel shell deteriorates under heat exposure.

For additional information, refer to the AISC *Engineering Journal* paper "Design of Concrete-Filled Hollow Structural Steel Columns for Fire Endurance" by Kodur and MacKinnon, first quarter, 2000. It can be downloaded from **www.aisc.org/ej**.

5. As a wide-flange shape cools, the flange tips and center of the web exhibit a faster rate of cooling than other portions of the cross-section. As these locations cool, they produce tensile stresses on the remaining hotter portions of the cross-section. Hence the centers of the flanges and ends of the web cool more slowly and become zones of tensile residual stresses. Both the tensile and compressive residual stresses are accounted for in the AISC *Specification*.

6. In such small components, the potential for yielding is minimal. As a result, the tensile strength is of interest and therefore used as the basis of design.

7. The positioning of a stud on a deck rib has a considerable effect on the stud design strength under horizontal shear. Many steel decks currently available contain a stiffening rib in the middle of the flute, precluding the placement of a stud at the center of the flute. A stud may be placed to the left or to the right of the stiffening rib. Depending on the shear-force direction and stud-placement location, a stud either will be located at a weak or a strong position. The location can be determined easily, since the weak-position stud will contain less concrete in the rib to resist the horizontal shear force compared to a strong-position stud, as illustrated below.



8. True, except for the case of shear on the effective area, where the design strength of the CJP groove weld is based on the base-metal yield strength and filler metal strength. Refer to Table J2.5 in the 1999 *LRFD Specification*.

9. For structural calculations such as local web yielding, k_{design} is appropriate because it is a lower-bound value. $k_{detailing}$ is used only for detailing purposes because it is an upper-bound value that ensures that continuity plates (transverse stiffeners) and doubler plates will fit between the flanges. The 3rd edition *LRFD Manual* accounts for current fillet radii in wide-flange shapes.

10. Yes. According to Section 3.1.2 of the 2000 *Code of Standard Practice* (a free download from **www.aisc.org/code**), data concerning loads, including shears, moments, axial forces and transfer forces, that are to be resisted by the individual members and their connections, sufficient to allow the fabricator to select or complete the connection details while preparing the shop and erection drawings shall be provided. ★