STEEL QUIZ

STEEL QUIZ, A MONTHLY FEATURE IN *MODERN STEEL CONSTRUCTION*, allows you to test your knowledge of steel design and construction.Unless otherwise noted, all answers can be found in the *LRFD Manual of Steel Construction*. To receive a free catalog of AISC publications, circle #10 on the reader service card in the back of this magazine.

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QUESTIONS

1. A tension hanger is made by welding a transverse ¾-in. thick plate to the bottom flange of a W24x55 beam at mid-span. Where is local yielding checked and what is the effective width over which it acts?

2. Why is the selection of C_b equal to 1.0 always conservative in beam design?

3. The torsional constant J can be accurately approximated for W-shapes and similar shapes of open cross-section as $\Sigma(bt^3/3)$ where b and t are the width and thickness of each element, respectively. Does this simple approximation also work for a hollow structural section (HSS)?

4. Which of the following ASTM Specifications is a production specification and not a material specification?
a) ASTM A572
b) ASTM A36
c) ASTM A6
d) ASTM A709
e) none of the above

5. The alignment charts for the determination of K values for compression members are based upon nine assumptions. How many can you name?

6. Name three common sources of residual stress.

7. Philosophically, what is the difference between a filler and a shim?

8. LRFD Specification Section B10 indicates that no deduction need be made for bolt holes in the tension flange for rolled wide-flange beams if $0.75F_u$ times the net flange area is greater than or equal to $0.9F_y$ times the gross flange area. If the tension flange has two ¾-in. bolts in standard holes on a given cross-section, what minimum flange width is required to satisfy this criterion in ASTM A36 steel? In ASTM A572 grade 50 steel?

9. Steel mills currently advertise and supply steel that is dual-certified as ASTM A36/A572-50. Why can the same steel be dual-certified to meet both ASTM material specifications?

10. What tolerance is applicable to the set elevation of leveling plates?

ANSWERS

1. Local yielding is checked in the web at the base of the fillet. The effective width per LRFD Specification Section K1.3 is $N + 5k = ¾ + 5(15/16) = 7.31$ in. Note that, if the transverse plate were within a distance equal to the depth of the beam from the beam end, the effective width would be reduced to $N + 2.5k$.

2. C_b is the moment gradient between points of lateral support for a beam and equals 1.0 when the moment is constant along that segment. Because this represents the worst-case flexural demand in that segment and, for all other cases C_b will be greater than or equal to 1.0, the use of C_b equal to 1.0 in design is always conservative.

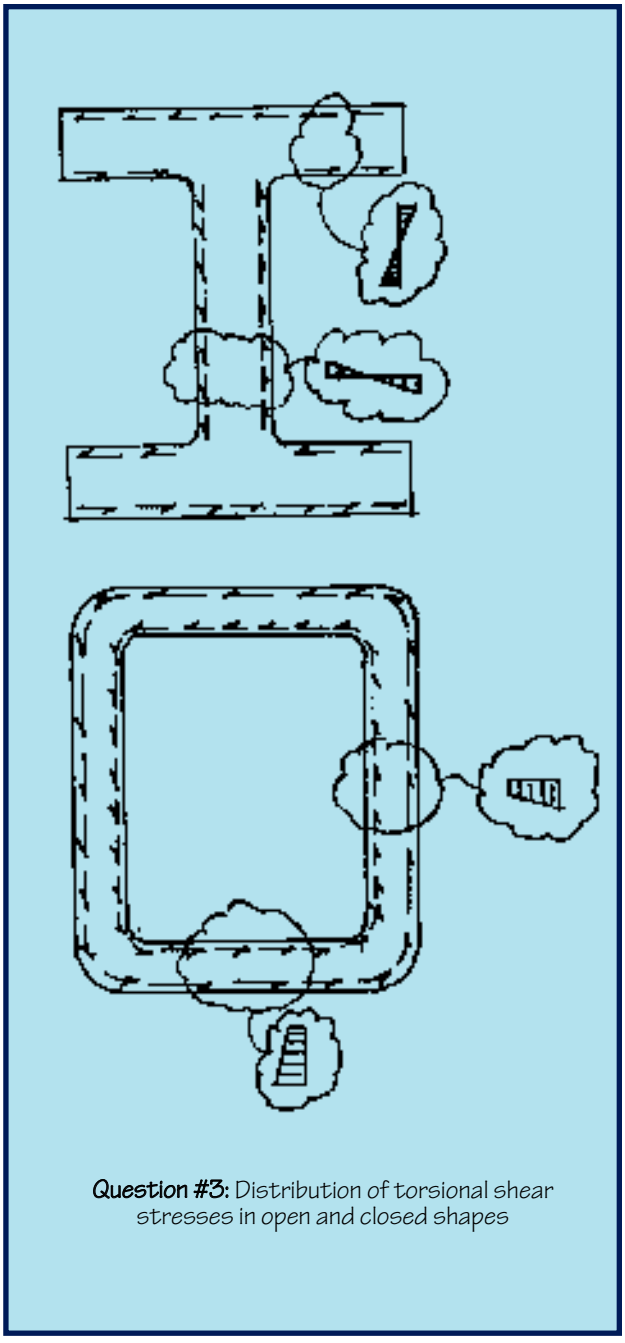
3. No, because the mode of torsional resistance differs. Open cross-sections resist torsion with in-plane shear stresses that vary linearly across the thickness of each element of the cross-section as illustrated below for a W-shape. Closed cross-sections resist torsion with shear stresses that are distributed over the thickness of the cross-section as illustrated below for a square HSS. See AISC's Design Guide #9 *Torsional Analysis of Structural Steel Members*.

4. **c.** ASTM A6 covers the cross-sectional dimensions and production tolerances for hot-rolled structural shapes. The others listed cover various material grades, including material tensile properties and chemistries.

5. From LRFD Specification Commentary Section C2, the nine assumptions are: (1) behavior is purely elastic; (2) all members have constant cross-section; (3) all joints are rigid; (4) for braced frames, rotations at opposite ends of beams are equal in magnitude, producing single-curvature bending; (5) for unbraced frames, rotations at opposite ends of beams are equal in magnitude, producing reverse-curvature bending; (6) the stiffness parameters $L\sqrt{P/EI}$ of all columns are equal; (7) joint restraint is distributed to the column above and below the joint in proportion to I/L of the two columns; (8) all columns buckle simultaneously; and, (9) no significant axial compression force exists in the girders. As noted therein, actual structures seldom satisfy these idealized conditions.

6. Common sources of residual stress include: cooling after rolling, cold bending, and weld shrinkage.

7. A filler is furnished to occupy spaces that will be present because of dimensional separations between elements of a connection. For example, a filler is used in a flange-plated column splice when wide-flange columns are of differing size. A shim is furnished for use during erection to fill spaces that may or may not be present because of the required field assembly clearances. For example, shimming may be required with moment end-plate connections for which the beam is typically fabricated short by a small erection clearance.



Question #3: Distribution of torsional shear stresses in open and closed shapes

8. For ASTM A36 steel, yielding on the gross area will control before rupture on the net area with a flange width that is at least 6.86-in. wide. For ASTM A572 grade 50 steel, the minimum required flange width jumps to 22.8 in. Thus, the tension flange area commonly must be reduced for bolt holes in a few wide-flange shapes in ASTM A36 material and **all** current wide-flange shapes in ASTM A572 grade 50 material.

9. There is a window of overlap in the tensile, chemical and other requirements for ASTM A36 and ASTM A572 grade 50 material. Consequently, one product can be produced to meet both specifications.

10. From AISC *Code of Standard Practice* Section 7.6, "Tolerance on elevation relative to established grades of bearing devices [such as leveling plates] … is +/-1/8 in."