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 **True/False:** When reviewing an existing structure that was originally designed using allowable stress design, the evaluation analysis must use the same approach.

2 **True/False:** Given a specific dead load and live load on a beam, that beam designed using LRFD load combinations will have a greater design strength, and thus greater capacity, than if the ASD load combinations had been used.

3 What is meant by the term *compact section*?

4 How can one determine if a section is compact or not?

5 **True/False:** If a beam shape is compact, the full plastic capacity can be used for the flexural design.

6 What is the difference between web local crippling and web local yielding?

7 What is shear buckling?

8 What is shear lag?

9 How many Seismic Design Categories are included in the ASCE 7 standard?
- **a.** two
- **b.** three
- **c.** four
- **d.** five
- **e.** six

10 **True/False:** A structure classified as Seismic Design Category C is not specifically required by ASCE 7-05 to be detailed in accordance with the AISC *Seismic Provisions* if $R = 3$ is used.

TURN PAGE FOR ANSWERS

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ANSWERS

1 **False.** The nominal strength of a structure or structural component is independent of the approach used in the analysis. One can select to use any load approach consistent with those permitted by the applicable building code or ASCE 7 standard. However, the evaluation must use the same approach on the strength side.

2 **False.** The nominal strength of the beam is not dependent on the load approach used in the design. Only the resistance factor applied for LRFD and the safety factor applied for ASD differ. Depending on the relative intensities of the dead and live loads, the LRFD or ASD approach may produce a more efficient design. They are essentially equivalent at a live-to-dead-load ratio of 3 for the load combination that considers dead plus live loading.

3 A compact section is one that is capable of developing full plastic stress distribution before the onset of local buckling of any of the components.

4 Compactness is determined based on local buckling as discussed in question 3. Local buckling can occur on a compression element if the element is too thin to accommodate the compressive force. The AISC specification defines limiting width-thickness ratios (*b/t* or *h/t*) for compression elements of various shapes, depending on whether these are stiffened or unstiffened, and if the stress distribution is uniform or not. The limiting width-thickness ratios for compression elements are listed in Table B4.1 of the *Specification* (a free download at www.aisc.org/2005spec).

5 This is a trick question, as not enough information is given to know if this statement is true or false. The full plastic moment capacity can be assumed if the beam member has adequate lateral bracing to prevent lateral-torsional buckling of the member itself. If the laterally unbraced length exceeds the limiting unbraced length for the limit state of yielding (L_p) of the shape, the flexural strength is reduced from the full plastic moment capacity. See Section F of the AISC specification for details. See the beam tables in Part 3 of the 13th edition manual for L_p of specific hot-rolled shapes.

6 Web local crippling is characterized as crumpling of the web into buckled waves directly beneath a compressive load. When this occurs, it will generally be in more slender webs. Web local yielding applies to both tensile and compressive forces of bearing beneath the load, occurring in stockier webs.

The limit state for web local yielding is covered in Section J10.2, and the limit state of web local crippling is covered in Section J10.3 of the AISC specification.

7 Shear buckling is the mode in which a plate element, such as the web of a beam, deforms under pure shear applied in the plane of the plate. Section G2 of the AISC specification covers the limit state of shear buckling.

8 Shear lag occurs when an axially loaded tension member has end connections that are not collinear with the load. An example would be fastening only one leg of an angle. In such a detail the connected leg becomes overloaded if the connection length is short enough to limit the amount of load that can be transmitted through the unconnected leg. This phenomenon is critical only in tension members because it relates to the rupture limit state, which is not a factor in the design of compression members. Also, as the length of the connection increases, the effect of the shear lag decreases. See Table D3.1 of the AISC specification for shear lag factors for connections to tension members.

9 **e.** Six Seismic Design Categories, A, B, C, D, E, and F are included in the ASCE 7 standard.

10 **True.** The classification of "Steel Systems not Specifically Detailed for Seismic Resistance Excluding Cantilever Column Systems" is permitted to be used in SDC A, B, and C in accordance with ASCE 7-05, when $R = 3$ is used. See ASCE 7-05 and Table 12.2-1 for further requirements.

Anyone is welcome to submit questions and answers 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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