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 2005 *Specification for Structural Steel Buildings*, available as a free download from AISC's web site:

www.aisc.org/2005spec

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 Steel Quiz is related to Chapter D, "Design of Members for Tension," of the 2005 AISC *Specification for Structural Steel Buildings*. A copy of this specification is available to download free from **www.aisc.org/2005spec**.

1. **True/False**: The maximum slenderness ratio permitted for design of members in tension is $L/r = 300$.

2. Which of the following does the ratio discussed in the first question not affect?

a. ease of handling
b. minimization of damage during fabrication
c. strength of the tension member
d. transportation and erection requirements

3. **True/False**: Tensile yielding and tensile rupture must always be checked when designing tension members.

4. How is the net cross-sectional area of an element containing one standard hole for a ¾″ diameter bolt determined?

a. t × (gross width–¾″)
b. t × (gross width–13/16″)
c. t × (gross width–7/8″)

5. What is meant by *effective net area*? How does it compare to *net area*?

6. What does the term *shear lag* represent in design of a tension member?

7. What are the minimum and maximum values for the shear lag factor, U?

a. 0.6, 1.0
b. 0.6, 0.9
c. 0.4, 1.0
d. 0.4, 0.9

8. The longitudinal spacing of intermittent welds or fasteners at tie plates, when used on the open sides of a built-up tension member, shall not exceed:

a. 3″
b. 6″
c. 9″
d. 12″

9. Select all limit states that apply to pin-connected members:

a. tensile rupture
b. shear rupture
c. bearing
d. yielding

10. **True/False**: Eyebars must be of uniform thickness.

Turn page for answers

Answers

1. **False**. Section D1 of the 2005 specification states that "there is no maximum slenderness limit for design of members in tension." However, a user note indicates that for design of tension members, "the slenderness ratio *L/r* preferably should not exceed 300."

2. The answer is **c**. That is, the slenderness limit for tension members recommended in the referenced User Note is not a function of strength. This is why the AISC specification does not require a slenderness limit for tension members. Refer to AISC FAQ 4.1.3 at **www.aisc.org/faq** for the basis of the tensile slenderness limit.

3. **True**. This requirement is found in Section D2. Note, though, that other limit states may also govern the design of the tension member and its connections. Such limit states may include block shear, bolt bearing on the thickness of the tension member, etc. Refer to Chapter J in the AISC specification for treatment of such limit states.

4. The answer is **c**; that is, the net cross-sectional area = t × (gross width–7/8″). The standard hole size for a ¾″ diameter bolt is 13/16″ diameter. The net width is based on subtracting 1/16″ greater than the standard hole size from the gross width.

5. The net area can be further reduced by a shear lag. The factor, U, is used to account for the effects of shear lag, which is a reduction in the effective area of a cross section as the stress flows from a uniform distribution in the member to a more concentrated distribution in the vicinity of connections that do not engage the full cross section for force transfer. Hence, effective area is simply the reduced net area, or $A_e = A_n U$. If $U = 1$, there is no reduction due to shear lag, and the effective net area will have the same value as net area. Refer to Section D3.3 for effective net area requirements.

6. Shear lag describes behavior at an end connection of a tension member where some but not all of the cross-sectional elements are connected. The area that is effective in resisting tension may be less than the full calculated net area for the cross-section. An example is a single-angle tension member connected by only one leg. The adjacent leg at the connection does very little in the way of resisting tension at the connection, but was fully effective beyond the connection out in the length of the tension member.

7. The answer is **a**. That is, the minimum shear lag factor value is 0.6, while the maximum cannot exceed 1.0. Refer to Table D3.1 for values of shear lag factors based on various configurations of tensile loaded elements. If a shear lag factor below 0.6 is contemplated, the tension member must be designed for the effects of combined loading due to the axial force plus the moment due to the eccentricity, per specification Section D3.3.

8. The answer is **b**, 6″. Refer to Section D4 for this built-up section requirement, as well as other dimensional constraints.

9. **All of the above**. Refer to Section D5.1 for the determination of each limit state. The lowest value obtained from these limit states governs the design.

10. **True**. The design procedure and dimensional requirements for eyebars in Section D6 require a uniform thickness. This section also notes several other dimensional requirements and constraints. ★