steel quiz

Most of the answers to this month's steel quiz can be found in the AISC *Specification*, AISC *Steel Construction Manual* and AISC Design Guides, as well as on the AISC and *Modern Steel Construction* websites.

1 Which of the following variables are used to calculate shear stress due to plane bending?
a) Q_f b) Q_w c) W_{ns} d) a and b

2 Match each figure below with the appropriate variable:

3 True or False: Two types of torsional shear stresses are considered when designing open cross sections for torsional loads.

4 The warping constant C_w is defined by which variable(s) listed below?
a) h_o b) I_y c) G d) a and b e) b and c

5 True or False: The warping constant C_w is used in the design of HSS subject to torsion.

6 True or False: A channel loaded through its center of gravity is not subject to torsion.

7 True/False: A W-shape beam with a moment connection does not necessarily have a torsionally fixed support.

8 True or False: Wind and seismic loads are considered to be static loads.

9 Which of the following types of column braces are addressed in AISC 360 Appendix 6?
a) Lateral b) Torsional c) a and b

10 True or False: When calculating the required strength and stiffness of beam braces, M_r is the required flexural strength of the beam based on a specific unbraced length.

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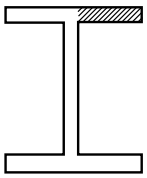
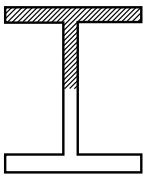
2 a)  b)  c)  d) 

Definitions:
i. Q_f for wide-flange
ii. Q_f for channel
iii. Q_w for wide-flange
iv. Q_w for channel

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1 d) Q_f and Q_w are used to compute the maximum plane bending shear stress in the flange and web, respectively. W_{ns} is used to calculate the normal stress due to warping torsion.

2 a) -i, b) -iii, c) -ii, d) -iv

3 True. Torsional shear stresses due to pure torsion and warping torsion are considered in the design of open cross sections for torsional loads.

4 d) In the case of a wide-flange beam subject to warping torsion, the top flange displaces laterally in one direction while the bottom displaces in the opposite direction. The section is more resistant to this warping if the flanges have large lateral moments of inertia and are far removed from the centroid. This is why C_w is related to I_y and h_o.

5 False. Torsion on a closed circular shape is resisted by shear stresses in the cross-section that vary directly with distance from the centroid. The cross-section remains plane as it twists (without warping) and torsional loading develops pure torsional stresses only. While non-circular closed cross sections do have some warping under torsional loading, this warping usually is negligible since longitudinal shear resistance prevents relative displacement of adjacent plate elements.

6 False. A channel loaded though its center of gravity will be subject to torsion. The shear center is the location through which an applied load will not induce torsional forces on the cross-section. In many shapes, the shear center and center of gravity coincide. In the case of a channel, the shear center is located on the opposite side of the web from the center of gravity.

7 True. It depends upon the rigidity of the support, and many supports cannot restrain the warping (thereby allowing torsional rotation). Since the top and bottom flanges warp in opposite directions, boxing the ends of the beam with plates can create the necessary restraint. Of course, this can be costly and as recommended in AISC *Design Guide 9*, the best approach for torsion is to eliminate it whenever possible.

8 True. The AISC *Specification* considers seismic and wind loads to be static loads—i.e., they are not considered fatigue loads. This has been clarified in the following 2010 AISC *Specification* definition. "Statically loaded: Not subject to significant fatigue stresses. Gravity, wind and seismic loadings are considered to be static loadings."

9 a) AISC 360-10 Appendix 6 Section 6.2 provides strength and stiffness requirements for column lateral braces. Torsional bracing is covered in addition to lateral bracing for beams in Section 6.3

10 True. M_r is the maximum moment between braced points, not necessarily the maximum moment along the entire span. This is outlined in detail in the AISC *Engineering Journal* paper "Fundamentals of Beam Bracing" by Yura (a free download for AISC members at **www.aisc.org/ej**).

Steel SolutionsCenter

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**.