

steel quiz

LOOKING FOR A CHALLENGE? This month's Steel Quiz highlights information that is available in AISC's recently published *Facts for Steel Buildings Number 3: Earthquakes and Seismic Design*. Written by Ronald O. Hamburger of Simpson Gumpertz & Heger, Inc., this publication is available as a free download at www.aisc.org/facts.

- 1 What does it mean when seismic design is described as a capacity design approach?
- 2 Which two recent earthquakes resulted in massive programs of research into the seismic behavior of steel frame structures?
- 3 How many modes of vibration does a three-degree-of-freedom model representing a three-story structure have?
 - (a) 1
 - (b) 2
 - (c) 3
 - (d) It has to be calculated.
- 4 What is modal analysis in seismic engineering?
- 5 How do Richter, moment magnitude and Modified Mercalli scales differ in assessing the severity of an earthquake?
- 6 True/False: The primary goal of U.S. building codes is to prevent building damage in an earthquake.
- 7 According to ASCE 7-05, when is compliance with AISC 341 required?
 - (a) For all structural steel systems in Seismic Design Categories D, E and F.
 - (b) For all structural steel systems in Seismic Design Categories B and C except when using $R = 3$ systems as per Table 12.2-1 in ASCE 7-05.
 - (c) For all composite structural steel seismic resisting systems other than those in Seismic Design Category A.
 - (d) All of the above.
- 8 Which of the following is not a reason seismic drift limits are imposed on buildings?
 - (a) To limit deformations to a range in which the analysis remains acceptable.
 - (b) To limit demand on diaphragms, chords and collectors.
 - (c) To limit damage in non-structural components.
 - (d) All of the above are true.
- 9 True/False: When using dual systems that include Special Moment Frames, 25% of the seismic load must be carried by the SMF irrespective of the lateral force distribution arrived at by analysis.
- 10 True/False: Structural drawings for projects in high-seismic applications must show the same information as drawings for low-seismic applications.

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ANSWERS

- 1 Capacity design is an approach in which certain elements are designed to undergo stable yielding in order to protect other members and connections and prevent structural collapse in an earthquake. See Section 3.14 *Facts for Steel Buildings Number 3: Earthquakes and Seismic Design* (available for free download at www.aisc.org/facts).
- 2 The magnitude 6.7 Northridge earthquake in 1994, and the magnitude 6.8 Kobe earthquake in Japan a year later, resulted in much research. This research improved U.S. seismic design and construction standards, including the AISC *Seismic Provisions* (AISC 341) [www.aisc.org/2005seismic].
- 3 (c) 3. A model with three-degrees-of-freedom has three modes of vibration (this ignores torsional degrees-of-freedom). See Section 2 of *Facts No. 3*.
- 4 Modal analysis is a convenient way to analyze the earthquake response of a multi-degree-of-freedom system as a series of single-degree-of-freedom systems. This form of analysis is considered to be sufficiently accurate if enough modes have been evaluated as per the requirements of the governing building codes.
- 5 Richter's scale uses a standard instrument, located at a standard distance, and approximate conversion factors. Moment magnitude is a direct calculation of the amount of energy released based on the surface area of the fault that has experienced movement, the amount of slip that has occurred, and the modulus of rigidity of the rock. The Modified Mercalli scale is based upon a qualitative table of observed effects of an earthquake at different sites. See Section 1.3 of *Facts No. 3*.
- 6 False. The primary goal of U.S. building codes is to limit the risk of collapse. Damage, however, is not limited and will vary in proportion to the severity of the shaking experienced. See Section 3 of *Facts No. 3*.
- 7 (d) All of the above. Said another way, the most common cases in which AISC 341 requirements do not apply are in Seismic Design Category A, and when an $R = 3$ system is used as permitted in Seismic Design Categories B and C.
- 8 (b) To limit demand on diaphragms, chords and collectors. See Section 3.9 in *Facts No. 3*.
- 9 True. According to ASCE 7-05, SMFs in dual systems must be able to resist at least 25% of the seismic load. See Section 7 in *Facts No. 3*.
- 10 False. High-seismic applications—those that are required to meet the requirements in AISC 341—have special requirements for their systems and the associated construction documents. See Section 4 of *Facts No. 3*.

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.

