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 is on walking vibrations and the AISC/CISC Design Guide 11, *Floor Vibrations Due to Human Activity*. It was submitted by Brad Davis, University of Kentucky, and Tom Murray, Virginia Tech.

1. Is the criterion for walking vibration in Design Guide 11 based on a heel-drop impact or resonance due to walking?
2. What peak acceleration is an acceptable level of vibration due to walking in a quiet environment?
3. What is the recommended damping for an office floor layout with demountable partitions on top and typical ductwork and ceiling below?
4. What are the recommended live loads for use in vibration calculations for (a) residences, (b) paper-oriented offices, and (c) electronic-oriented offices?
5. What is the recommended vibration dead load in addition to the weight of the structural system?
6. Why is a typical concrete on deck and rolled steel beam structural system considered fully composite for vibration analysis even if it is designed and constructed as a non-composite system?
7. True/False: Joist seats are fully effective shear connectors for vibration.
8. What are "beam panels" and "girder panels" according to AISC Design Guide 11?
9. What is the upper limit of the effective width of "beam panels" and "girder panels?"
10. When can the effective weight of "beam panels" be increased by 50%?

ANSWERS

1. The criterion for walking vibration in Design Guide 11 is based on resonance caused by walking. Previous criteria were based on a heel-drop impact, but those are no longer recommended. Low levels of damping found in modern buildings, mainly because of open office layouts, may result in resonant response of floors, which necessitated this change.

2. A peak acceleration of 0.5% of gravity (0.005 times the acceleration of gravity) is an acceptable level of vibration due to walking in a quiet environment (See Table 4.1 of Design Guide 11).

3. The recommended damping for an office floor with demountable partitions on top and typical ductwork and ceiling below is 3% of critical damping (See Table 4.1 of Design Guide 11).

4. (a) The recommended vibration live load for residences is 6 psf. (b) For paper-oriented offices it is 11 psf. (c) For electronic-oriented offices it is 6 to 8 psf. These values represent actual day-to-day loads as recommended in Chapter 4 of Design Guide 11 and ASCE-7-05 Table C4-2.

5. The vibration dead load recommended in Design Guide 11 (Chapter 4), in addition to the weight of the structural system, is 4 psf for typical ductwork and typical suspended ceilings. A larger value should be used for heavier ceilings and if raised floors are part of the fit-out.

6. Vibration loads produce very little horizontal shear at the deck/beam flange interface. Even deck-to-flange puddle welds are sufficient to cause full composite action for these small shear loads. Therefore, typical non-composite concrete on deck and rolled steel beam systems are considered fully composite for the vibration analysis.

7. **False.** Full-scale testing has shown that joist seats are not fully effective shear connectors for vibration because of their transverse flexibility. See Design Guide 11, Section 3.6 for details.

8. The term "beam panel" defines the area of the floor associated with the beam vibration mode (along with no girder bending) from which the beam panel mode effective weight is calculated. Similarly, the term "girder panel" defines the area and effective weight associated with the girder panel vibration mode.

9. The upper limit of the effective width of "beam panels" is two-thirds of the entire floor width (width of floor perpendicular to the beam span) and the upper limit for "girder panels" is two-thirds of the entire floor length (length of floor perpendicular to the girder span). These limits apply to Design Guide 11 Equations 4.3a and 4.3b as illustrated in the examples of Chapter 4.

10. The effective weight of "beam panels" can be increased by 50% when the beams are shear connected to the girders and the adjacent span is greater than 70% of the beam span associated with the beam panels (Design Guide 11 Section 4.2). Increasing the beam panel weight reduces the predicted acceleration.

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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