Continuing Education Course #158
Industrial Floor Framing
for Vibrating Equipment

1. Floors that support vibrating equipment must have a natural frequency that differs from the equipment operating frequency in order to avoid resonance and the resulting large vibrations only because:
- a. vibrations may cause discomfort to equipment operators
- b. vibrations may cause equipment to operate incorrectly
- c. vibrations may result in damaged equipment
- d. all of the above

2. Determining the natural frequency of a support is so complicated that a computer program must always be used to calculate it.
- a. true
- b. false

3. A support will only vibrate in one frequency and that frequency is known as the natural frequency.
- a. true
- b. false

4. When determining the natural frequency of a support, only the following loads are used:
- a. all dead loads that are firmly attached to the support, including equipment and support weights
- b. dynamic loads
- c. all dead and live loads
- d. equipment weight when attached to the support with springs

5. Most situations involve beam and equipment arrangements for which a natural frequency value is not published in the literature, consequently it must be computed. However there are simple situations for which natural frequency values have been published.
- a. true
- b. false

6. A simply supported beam with a concentrated weight at mid-span can be compared to a spring supporting a mass, typically known as a single degree of freedom system. Formulas for the natural frequency of the latter can then be used to calculate the natural frequency of the beam.
- a. true
- b. false

7. Static-deflection methods for calculating a system natural frequency require:
- a. calculation of the system load carrying capacity
- b. calculation of deflection of concentrated masses
- c. calculation of the maximum deflection of the entire system

8. The Southwell-Dunkerley method lends itself to hand calculations because:

○ a. the method is only accurate to two significant figures

○ b. the method was developed before computers were invented

○ c. the method requires calculation of the deflection of individual masses, acting independently, which can be done using formulas familiar to structural engineers

9. Is the Rayleigh Method more accurate than the Southwell-Dunkerley Method?

○ a. yes, because calculations are done by computer

○ b. yes, because the formula is more complex

○ c. no, the method simply supplies a value of natural frequency larger than the real value (an upper bound) while the Southwell-Dunkerley method supplies a value lower than the real value (a lower bound).

10. If the upper and lower values of natural frequency calculated for a system by the methods mentioned in previous two questions are far apart, it means that:

○ a. the value of the natural frequency of the system is not known accurately

○ b. the system is unstable and will readily vibrate

○ c. the system requires more mass to become stable

11. When using STAAD's "Calculate Rayleigh Frequency" Command, all the loads are applied simultaneously, with the condition that the forces of gravity act in opposite directions on opposite side of supports.

○ a. yes

○ b. no, the loads must be input in the direction that they actually act so as to obtain an accurate answer.

○ c. no, all the loads must be applied acting in one direction

12. When using STAAD's Modal Calculation Command, all the loads are applied simultaneously, with the condition that the forces of gravity act in opposite directions on opposite side of supports.

○ a. true

○ b. false, the dead loads must be applied simultaneously but all should be directed downward

13. The STAAD Command "Modal Calculation Requested" calculates theoretical exact answers of the system frequencies for each mode of vibration for a system consisting of elements with distributed mass.

○ a. yes, the frequency values calculated are theoretically exact

○ b. no, the frequency values calculated are a rough approximation

○ c. no, the frequency calculated are not theoretically exact for a system consisting of elements with distributed mass. The answers are exact for a system represented by masses concentrated at the joints.

14. When modeling a support within the STAAD program, in order to obtain an accurate value for the natural frequency, it is very important to create a joint at each location where a significant dead load occurs. This applies for both the 'Calculate Rayleigh Frequency" and the "Modal Calculation Requested" commands.

○ a. true

○ b. false

15. It is better to design "high tuned" floors, i.e., floors that have a natural frequency larger than the operating frequency of the supported equipment, rather than to design "low tuned" floors.

○ a. yes, because it costs less to design floors with higher natural frequencies.

○ b. yes, because with high tuned floors the natural frequency of the floor is never approached, not even when the equipment is started or shut down.

○ c. no, it is better that the floor's natural frequency be smaller than the frequency of the operating equipment.

16. Equipment manufacturers should always be consulted regarding their recommendations for parameters such as support's natural frequency, impact factors, and support to equipment mass ratios.

○ a. yes

○ b. no, recommended values can be obtained in books that deal with vibration.

17. Equipment manufacturers always indicate in their vendor drawings the information that is important for support design such as: dynamic loads, operating frequencies and weights of equipment.

- a. yes
- b. no

18. The two most common causes of excessively vibrating floors are: one, the floor natural frequency being too close to the equipment operating frequency and two, the equipment being out of balance.

- a. true
- b. false

19. For floors with beams that are less than 20 feet long, framed directly into columns, and that support vibrating equipment, the recommended ratio fn/ff, has been set to > 1.5 for "high tuning" and < 0.8 "for low tuning" so as to provide an equivalent safety factor in both situations against excessive vibrations.

- a. true
- b. false

20. The natural frequency of a floor that supports vibrating equipment should never be lower than the operating frequency of the equipment.

- a. true
- b. false

21. Concrete floors are better than steel floors for supporting vibrating equipment because concrete has more internal damping than steel.

- a. true
- b. false

22. A floor that only supports vibrating equipment can be designed to have larger vibration amplitudes than a floor that supports vibrating equipment plus access platforms.

- a. true
- b. false

23. Floors designed to support vibrating equipment usually have significantly more strength capacity than those required to support the dead, live, equipment and dynamic loads.

- a. true
- b. false

24. When designing floors to support vibrating equipment, the live load impact factor is the most critical factor.

- a. true
- b. false

25. If a floor design meets the fn/ff ratios recommended by the manufacturer and by Table 2, then it is guaranteed that the floor will not vibrate excessively when the equipment is operating.

- a. true
- b. false