

Control of Floor Vibration

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Excessive floor vibration has become a greater problem as new rhythmic activities, such as aerobics, and long-span floor structures have become more common. This Update describes the nature of floor vibration and provides options for avoiding it through design, or in the case of existing buildings, reducing or eliminating it through alterations.

Floor vibration is up-and-down motion caused by forces applied directly to the floor by people or machinery, or by vibration transmitted through building columns, from other floors or from the ground.

The problems associated with floor vibration are not new. In 1828 Tredgold wrote “girders should always be made as deep as they can to avoid the inconvenience of not being able to move on the floor without shaking everything in the room.”¹ A simple floor deflection criterion (deflection of less than span/360 under distributed live load) has been used to control ‘excessive shaking’ for more than 100 years. But today, when longer spans, thinner floor decks, less structural damping (an absence of materials and components that absorb vibration energy), or the use of buildings for activities such as aerobics are responsible for vibration problems, this approach does not work. However, new guidelines that address and deal with these problems — based on what people perceive and find acceptable in terms of floor vibration — have recently been introduced.

Vibration Limits

Floor vibration generally makes people uneasy and creates fear of structural collapse, although such fear is usually unwarranted because of the small displacements and stresses that are actually produced. Nevertheless, perceptible vibration is usually considered to be undesirable because it affects people’s sense of well being and their ability to carry out tasks.

Vibration limits, or acceptable thresholds, are best expressed in terms of acceleration, as a percentage of the acceleration due to gravity (g). The limit depends primarily on the context, that is, on what people are doing when they experience the vibration. For example, people sitting or lying down in offices or residences find distinctly perceptible vibration (accelerations of about 0.5% g) unacceptable, whereas those taking part in an activity such as aerobics will accept much greater vibration (about 10% g). People dining beside a dance floor or standing in a shopping mall will find vibrations that fall between these two extremes (about 2% g) acceptable.

Generally, it is not the participants in a particular activity or event who are most disturbed by floor vibration, but those who are located in adjacent spaces, as they find it annoying or disruptive to their own activities.

If the vibration is very large (more than 20% g), and occurs frequently (e.g., in a health club), then fatigue failure of the floor can occur. To prevent collapse due to fatigue or overloading, the National Building Code of Canada (NBC) requires a dynamic analysis of a floor structure if it has a natural frequency of less than 6 Hz.²

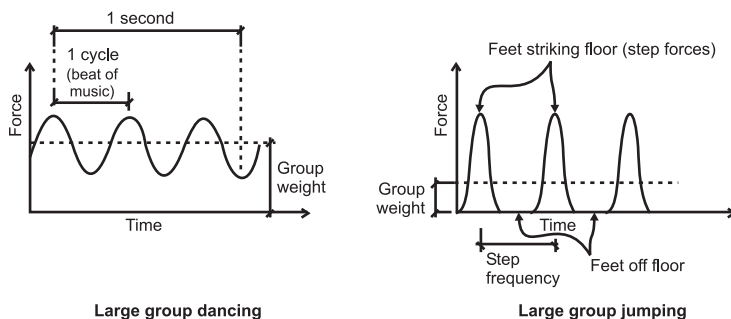


Figure 1. Repetitive forces produced by human activities