

Sound Transmission

By Ronald L. Geren, AIA, CSI, CCS, CCCA, SCIP

One of the biggest complaints in multi-tenant housing facilities is noise. Most noise issues are addressed at the management level, with some cases moving into the courts. In some cases, noisy neighbors can lead to tragic results. Take one Lambrinos Lykouresis, for example.

Mr. Lykouresis was a 78-year-old resident of Lithakia, on the Greek island of Zakynthos. According to a July 1998 *Time Magazine* article, it was May of 1996 when Mr. Lykouresis couldn't tolerate the noise emanating from his next door neighbor's apartment any longer. He grabbed his hunting rifle, went to the neighbor's apartment and rang the bell. When the resident answered the door, he fired 3 times, killing the 40-year-old housewife and wounding her 24-year-old son. Fortunately, justice prevailed and Mr. Lykouresis is now serving two life sentences. Albeit, this is an extreme case, but it underscores the importance of proper sound control in buildings; especially in residential buildings.

Noise as a nuisance is a very subjective matter. Some may consider any perceptible sound from a neighbor's residence to be a nuisance, while others just consider it a part of everyday life in multi-tenant living. In any case, nobody ever complains about it being too quiet. Therefore, building codes have taken steps to further their intent of providing for the "general welfare" of the public by incorporating provisions in the building codes to minimize sound transmission through building walls and floors.

The two current model building codes, the *International Building Code* (IBC) and the *Building Construction and Safety Code* (NFPA 5000), have similar requirements, with one noticeable exception: The IBC limits its requirements to only multi-family dwellings, while the NFPA 5000 additionally applies its requirements to hotels, dormitories, lodging and rooming houses, and residential board and care facilities.

Although noise is high on the complaint ladder, the building codes have provided very little space addressing the issue; four paragraphs in the NFPA 5000, and three in the IBC. Nevertheless, when you read the provisions, you'll become keenly aware of the reason for their diminutive length: performance. Unlike most other provisions of the building code where mandatory prescriptive requirements are indicated, the sound transmission requirements are purely performance-based.

There are two types of sound transmission addressed in the building codes. The first type is air-borne sound, which is sound that radiates through the air. Examples of air-borne sound are people talking and music playing. The second type is structure-borne sound, which is sound that is transmitted in the form of vibration and re-radiated at another point. An example of structure-borne sound would be tapping on one end of a length of pipe and hearing it at the other end.

As I previously mentioned, the requirements of the IBC and NFPA 5000 are very similar, but for the remainder of this article, I'll focus on the specific provisions of the IBC.

For air-borne sound, the IBC requires that applicable walls, partitions and floor/ceiling assemblies have a sound transmission class (STC) of 50 when tested in a laboratory using ASTM E 90, *Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*. An STC is a single number that represents the effectiveness of materials or construction in retarding the

transmission of air-borne sound. At STC 50, loud speech may be audible, but not understood. Like fire-resistance ratings, many standard wall and floor/ceiling assemblies have documented STC ratings. For wood and metal construction, the Gypsum Association has a number of assemblies in their *Fire Resistance Design Manual*, GA-600, with STC ratings. For masonry, the National Concrete Masonry Association (NCMA) has TEK 13-1A, *Sound Transmission Class Ratings for Concrete Masonry Walls*, that provides some common masonry assemblies with tested STC ratings. Another excellent resource for STC ratings of gypsum board partitions is the National Research Council (NRC) Canada's Institute for Research in Construction reports IRC-IR-693 and 791. For floor/ceiling assemblies, NRC's IRC-IR-766 provides ratings for a variety of systems. All reports are available on the internet at <http://irc.nrc-cnrc.gc.ca/ircpubs/>.

To be accepted by most building departments, assemblies incorporated into a project must be designed and installed according to the tested assembly. To ensure the wall meets the required rating, any penetrations or openings need to be "sealed, lined, insulated, or otherwise treated" to prevent sound leakage. Leaks may occur at outlet boxes, pipe penetrations, and ductwork. The exception to this is dwelling entrance doors. They don't have to meet the STC requirements, but they must fit tight to the frame and sill.

If you have a unique situation which hasn't been tested in the laboratory, the code does permit the use of a field test to ensure sound transmission requirements are met. The field method tests the assembly "as installed." Fortunately, the code permits a reduction in the required STC to 45 since it lacks the benefits of a controlled laboratory test. The one thing the code doesn't address is how to conduct the field test.

To conduct a field test, the recommended method is ASTM E 336, *Standard Test Method for Measurement of Airborne Sound Insulation in Buildings*. This method is specifically developed for testing the sound insulation between two rooms in a building. It establishes procedures to determine the field STC, or FSTC, by reducing the influence of flanking paths so that the performance of the partition is evaluated. Flanking paths occur when sound travels through the floor, ceiling, or adjacent walls into the space, bypassing the assembly in question. You'll notice I stated "reducing the influence," because there is no way to eliminate the influence of flanking paths. Hence, the reason for the building code lowering the STC requirement for field tests.

For structure-borne sound, the IBC requires floor/ceiling assemblies to have an impact insulation class (IIC) of 50 when tested in accordance with ASTM E 492, *Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine*. The IIC measures the level of resistance to transmission of noises through floors and ceilings generated by impact sounds, such as footsteps and movement of objects. GA-600 and IRC-IR-766, both listed above for STC ratings, provide tested IIC ratings for many wood, steel, and concrete assemblies. Some of the assemblies listed do not include floor finishes in the IIC ratings. In those cases, adding carpet and pad will significantly increase the IIC rating. In a technical bulletin published by the Carpet and Rug Institute, adding carpet alone can increase the IIC almost 60%, while adding carpet and a pad can more than double the IIC rating.

The IBC also permits the use of field testing to determine the IIC of an installed floor/ceiling assembly. Like the STC, the rating is reduced to 45 due to the imperfect nature of field conditions. And, just like field testing for the STC, the IBC doesn't establish the procedure for field testing the IIC. The recommended test method for determining the field IIC, or FIIC, is ASTM E 1007, *Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling*

Assemblies and Associated Support Structures. If a field test is used, you need to be aware of the minimum aging periods before any tests can be conducted, which vary from 3 to 28 days depending on the type of materials used.

Complying with just the minimum requirements of the IBC may not keep you out of trouble when it comes to sound transmission. Many municipalities have developed noise control standards that may or may not be included as amendments to the adopted building code. These regulations may apply to more than just residential construction, too. For example, the City of Peoria, Arizona, located within the metropolitan Phoenix area, is also in close proximity to Luke Air Force Base. Peoria, along with other municipalities around Luke AFB, has developed additional requirements to reduce interior noise generated by the fighter aircraft flying into and out of the base. Luke AFB, as well as other military and commercial airports, has developed noise contours establishing the average day-night noise levels (called DNLs) in decibels (dB) around the base perimeter. Buildings within these contours must be designed so that the interior noise level does not exceed 45 dB. To illustrate this, if a building is within the 60 dB contour, its exterior walls, doors, and windows must reduce the noise level by 15 dB.

Noise will always be an issue in multi-tenant housing. Some noise, such as music, is very difficult to control. But the intent of the building code is to be reasonable about noise control, and as a result it requires reduction, but not elimination, of sound transmission. Owners may increase the requirements to minimize complaints, but as long as architects and contractors comply with the minimum requirements of the building code and other noise regulations, they shouldn't hear a thing after the project is completed.

To comment on this article, suggest other topics, or submit a question regarding codes, contact the author at ron@specsandcodes.com.

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