

The Sounds of Silence

BY ROB KINCHLER, P.E.

Dispelling the myths about structural steel and sound transmission.

GETTING A GOOD NIGHT'S SLEEP at a hotel can be tough if you have a noisy neighbor. Many of us have experienced this problem at one time or another, faced with the dilemma of making the complaint call to the front desk or suffering through a restless evening.

The same can be said for the owner of a condominium trying to enjoy a peaceful night at home when the party next door sounds like it's in their own unit. Owners, developers, and architects are thus keenly aware of how important it is to prevent objectionable sound transmission in residential buildings.

A myth exists that a residential building, such as a hotel or condominium, framed in structural steel will be noisier than one framed in concrete or masonry. In fact, it is the characteristics of the separating elements—not the beams and columns—that make or break sound transmission performance. Thus, a successful acoustic design of wall and floor systems between units is what matters.

The August 2006 SteelWise article “Can You Hear Me Now?” (available at www.modernsteel.com) explored the issue of sound transmission in buildings. The article explained that sound energy is measured in decibels (db), how the suitability of a structural assembly to block sound transmission is rated via Sound Transmission Class (STC) and Impact Insulation Class (IIC) ratings, and how different products can help alleviate acoustical problems. I'd like to further explore the topic of sound transmission, particularly addressing STC ratings of wall and floor assemblies.

Making Sound Comparisons

STC ratings measure how well a sound barrier blocks airborne sound transmission. However, these ratings only address airborne sound in the medium- to high-frequency range (125 Hz to 4,000 Hz), which corresponds to normal and amplified speech. A wall assembly with an STC rating of 50 db can reduce 110 db of airborne sound on one side of the wall to 60 db airborne sound on the other. This is the equivalent of reducing the noise level of a rock concert to the level of normal speech. (We'll stay focused on the medium- and high-frequency range, but it should be noted that low-frequency sounds, such as bass from the subwoofer in a home theater system, cannot be addressed by STC ratings; acoustical drywall, constrained layer damping, and mechanical decoupling can be used to reduce low-frequency sound transmission.)

Impact Isolation Class (IIC) ratings measure structure-borne sounds resulting from sound producers like washers and dryers, exhaust fans, or footsteps. Most floor assemblies need additional enhancements, such as carpets and underlayment, to raise the IIC rating of a floor assembly to code-required minimums. Table 1 (Assembly Ratings) on page 58 shows IIC ratings for the various floor/ceiling assemblies.

In residential applications, Section 1207 of the 2006 *International Building Code* requires a minimum STC rating of 50; minimum requirements in other major building codes are similar. However, high-end properties may be constructed to achieve STC values greater than 60 to provide better reduction levels. The STC rating then has great influence on the construction of walls and floors.

STC ratings for different wall and floor assemblies are dependent on such factors as the material types used, their mass, and air space included in the assembly, if any. Some common assembly ratings are shown in Table 1. When details in the actual construction differ, the rating may be improved. For example:

1. Doubling the mass of the assembly will add 5 points.
2. Including an airspace will add 2 points per inch of thickness.
3. Adding insulation in the airspace will add 5 points.

Note also that cold-formed steel studs typically will have higher STC ratings than wood studs due to flexibility. Since wood studs are more rigid, they transmit sound more easily because they dissipate less sound energy than flexible cold-formed steel studs, and therefore have a lower STC rating. (Again, see Table 1.)

One challenge that arises in sound design is that these STC ratings are for wall or floor assemblies that were tested in a laboratory in accordance with the requirements in ASTM E90. In real construction, it is important that the assemblies are built consistent with the details as tested. Even more important, flanking paths that allow sound to travel



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unimpeded through air around the assembly (see Figure 1 below) can quickly compromise the performance of even the highest-rated barrier assembly. The elimination of flanking paths requires careful attention, especially at mechanical ductwork, piping runs and other penetrations, door and window openings, electrical switches and outlets, and barrier edge treatments at intersections with structural elements and other barriers.

Micro vs. Macro

Acoustical consultant Alan Burt of SSA Acoustics in Seattle (www.ssaacoustics.com) points out that the designed airborne sound transmission of an assembly is a function of how the assembly itself is put together, and not the *building's* structural framing. In other words, all other variables being equal, the frame choice—whether steel, concrete, or masonry—is not the driving factor in achieving the desired STC ratings. Rather, the important questions to consider in designing for the acoustical quality of a building include:

1. Are the selected wall and floor assemblies appropriate for the reduction of noise required?
2. How well are the selected wall and floor assemblies constructed in the field?

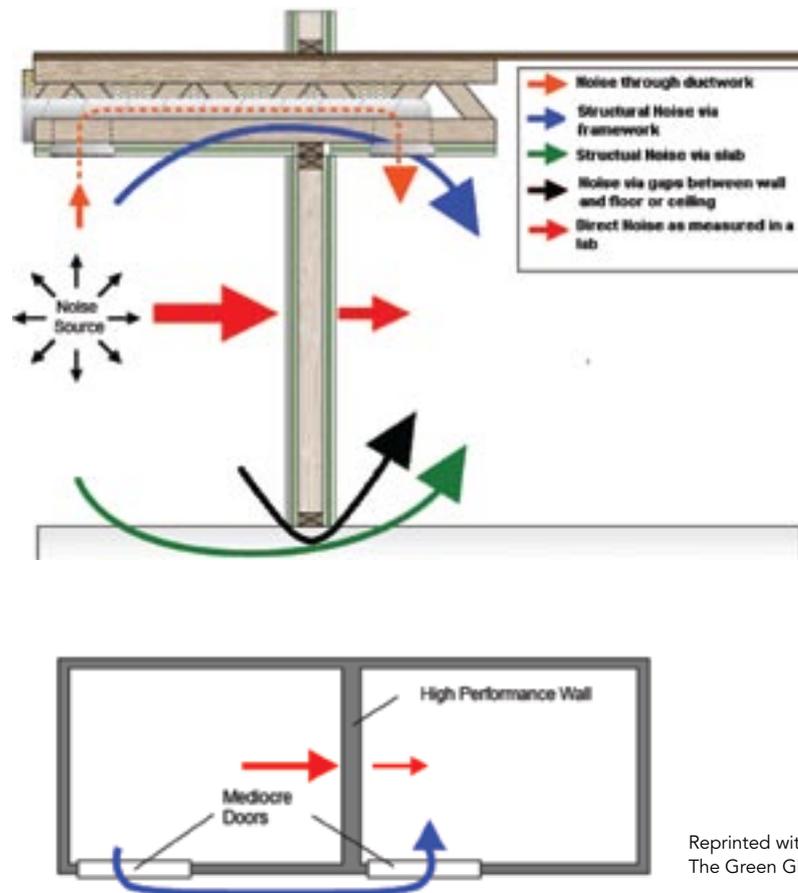
3. Are the alternate flanking paths being addressed?
4. How does the framing affect other noise or vibration issues (i.e., mechanical equipment, instrumentation affected by vibration, floor response, etc.) and how does this need to be addressed?

For example, in a high-end condominium, the demising walls may be built with cold-formed single-row studs, two layers of drywall, and insulation (option 6 in Table 1). This assembly has an STC value of 56, which is marginally below the STC rating of 60 recommended for high-end properties. Increasing the airspace or using resilient channels will increase the STC rating to 60. The *Fire Resistance Design Manual*, published by the Gypsum Association, and USG's *Drywall Steel Framed Systems* guide have other generic and proprietary wall and floor systems to further improve STC ratings.

Option 6 also provides a two-hour fire-rated wall when used with drywall. If the wall encapsulates the structural steel framing, then no cellulose or cementitious spray-on fire protection is required. Thus, the steel structure is fire protected at no additional cost with higher STC requirements. On the other hand, if masonry walls like option 1 or option 3 are selected, the STC ratings would be comparable to insulated cold-formed stud walls, but

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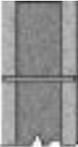
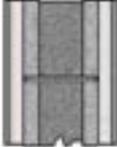
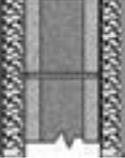
Figure 1: Flanking Paths



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Table 1: Assembly Ratings

Tested Wall or Floor		Rating	
		STC	IIC
1.	 8" CMU Wall (Exposed)	48	NA
2.	 8" CMU Wall 2" Z-Bars (Each Side) 1/2" Drywall (Each Side)	52	NA
3.	 8" CMU Wall (Covered) 3/8" Steel Studs (Each Side) 1 Layer Drywall (Each Side) 1 Layer Insulation (Each Side)	64	NA
4.	 3/8" Steel Studs 1 Layer Drywall (Each Side)	39	NA
5.	 3/8" Steel Studs 1 Layer Drywall (Each Side) Batt Insulation	45	NA
6.	 3/8" Steel Studs 2 Layers Drywall (Each Side) Batt Insulation	56	NA
7.	 6" Concrete Floor Slab	53	27
8.	 8" Concrete Floor Slab	55	30
9.	 4" Concrete Floor Slab on Metal Deck (1 1/2" Metal Deck, 2 1/2" Conc.)	43	20
10.	 6" Concrete Floor Slab on Metal Deck (3" Metal Deck, 3" Conc.)	51	21
11.	 8" Hollowcore Precast Plank	53	28

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the masonry options would weigh considerably more than option 6 and require a larger overall wall thickness, encroaching on valuable real estate.

When attempting to meet certain STC rating requirements, one must keep in mind that the in-field construction of the wall assembly should be as similar as possible to the tested conditions; any openings in the wall assembly should be properly sealed off (electrical outlets, plumbing penetrations, etc.). If the ductwork in the unit is connected in some fashion with other units, acoustic consideration needs to be addressed to prevent sound emanating from one unit to the next via the ductwork. The location and quality of doors and windows within a wall assembly can greatly compromise the actual STC rating achieved.

From Walls to Floors

From Table 1, an 8-in. concrete floor slab (option 8) has an STC rating of 55. With option 10, a concrete floor slab on metal deck (3-in. metal deck with 3-in. concrete topping), an STC rating of 51 can be achieved. Additionally, for an 8-in. hollow-core precast plank (option 11), the STC rating is 53. These options are not based on the building framing, whether steel or concrete, but on the STC rating desired.

All of these options meet the typical STC rating requirement in the building code of 50; however, additional measures are required to bring the STC rating up to 60 for more stringent requirements. Options to achieve this rating include providing a drywall ceiling suspended with resilient channels, sound insulation, and/or an underlayment product.

SSA Acoustics' Alan Burt describes the performance of floor/ceiling assemblies in a luxury-grade condominium project on which he recently consulted. The assemblies between living areas were constructed with hardwood floors installed on an acoustical underlayment over a 3-in. concrete slab on metal deck. The metal deck supported a ceiling below, which consisted of two layers of 5/8-in. drywall backed by 3 1/2-in. fiberglass insulation connected to the deck with resilient channels. The tested STC rating of this assembly was 69. Thus, an STC rating greater than 60 was achieved with a 3-in. concrete slab on metal deck as the structural basis for the assembly.

Sound Advice

There are many variables that must be considered when designing a quiet building, and it may be wise to enlist the services of an acoustical design professional. This type of consultant can provide options and help to determine the best assembly for a particular application, give guidance on construction practices to be implemented as well as avoided, and help to avoid and address problems that occur when trying to achieve that rating in the field, such as location and isolation of sound leaks in the specified wall assembly.

Dispelling myths and false perceptions is always a challenge. But it would appear that sound transmission problems based upon the choice of structural framing material alone seem to have become a well-established myth with no basis in fact. Armed with this "sound advice," you can educate your clients and work with them to make decisions—based in fact, not myth—to help them achieve the acoustical performance they desire.

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