Sound Advice

Helpful Information from ***Stewart Acoustical Consultants*** 919-858-0899
A member firm of the National Council of Acoustical Consultants copyright 2011
7330 Chapel Hill Road, Suite 101 Raleigh, NC 27607 www.sacnc.com

SOUND BLOCKAGE OF WALLS AND STRUCTURES

By Noral D. Stewart

Sound blockage is one of two primary factors influencing privacy, with the other being the available masking sound. Very quiet background sounds sometimes require extreme sound blockage.

Most solid walls with no open leaks will provide 40 to 50 dB of blockage for middle frequency sound. This is somewhat amazing if you consider that 40 dB amounts to blocking 99.99% of the sound, and 50 dB amounts to blocking 99.999%. With special care, blockage up to 60 dB or more can be achieved. However, success beyond 50 dB depends on careful construction, and is often limited by flanking or sound leakage by paths around the wall, door or window. A small leak can have a major effect on a wall with otherwise high blockage.

Higher frequency sound is easier to block than low frequency or bass sound. The bass sound has longer wavelengths. The wall looks thinner to the low-frequency sound. Walls are rated in their ability to block sound by the Sound Transmission Class (STC). Their blockage of bass sound will be less than the STC. The STC can be misleading, as the wall with the lower STC may actually be better for a particular application. The wall with the higher STC may actually be a poorer blocker of bass sound. A less known but better rating method for exterior walls and windows is the Outdoor-Indoor Transmission Class or OITC. The OITC rating for a particular structure will be 2 to 17 points less than the STC.

The major factor that influences the blockage of the structure is its weight. However, the efficiency of the material used can be improved by separating it into isolated layers. The more separation space provided, the greater the increase in blockage. For instance, suppose you have a layer of material that by itself blocks 20 dB. If you double the thickness of the layer, the blockage is improved by about 5 dB at most frequencies. However, if you use two layers well separated from each other, the blockage can be increased 20 dB or more at some frequencies. The problem is in establishing good separation, especially for lower frequencies. The improvement for bass sound may be only about 5 dB. To achieve the best improvement with isolated layers, the cavity between layers must contain sound-absorptive material, and the connections between layers should be flexible. Light gauge steel studs provide better isolation than wood studs. Resilient channels can be added to one side of wood studs to increase the flexibility. Two sets of studs can provide even better results even if wood.

All solid materials will have a weak point at a "critical" frequency. This frequency is lower and thus more of a problem for thick, stiff materials. The critical frequency of a thin, limp sheet of lead is very high. The critical frequency of many common materials is in the frequency range of speech. The effect of the critical frequency can be reduced by adding a vibration damping effect. An example is the laminating layer in safety glass. Several new laminated gypsum products use a damping agent between two thinner layers of gypsum. Special damping glues are also available to put between layers of gypsum. Another way is to use several layers of thinner material to raise the critical frequency. Using layers of different thicknesses assures that one layer will be strong at the critical frequency of another. The thickness of the thinnest layer should not be more than 60% of the thickness of the thickest layer. A ¼ inch layer of gypsum sold as a sound deadening board is helpful for this. Mixing 3/8 inch and 5/8 inch layers also helps.

Structureborne sound, such as footsteps on a floor above, constitutes a more difficult problem. The structure itself becomes the noise source, rather than a blocker of the noise. Other examples of structureborne sound are plumbing and mechanical equipment that is not isolated from the structure. Sometimes very loud airborne sound can excite a structure (such as a side wall or roof) and become structureborne around a good wall, or travel and be heard in space that is not even directly adjacent. This is called flanking and is a common limitation if a floor, ceiling, or wall perpendicular to the dividing partition is continuous between two spaces.

Masonry walls are very good for blocking low-frequency bass sound. Filling a masonry wall with heavy material such as sand or mortar can help due to the extra weight. Lightweight filler such as foams do not help significantly. (Beware of misleading advertising – read test reports and look at the overall weight of walls tested.) At least one side of the wall must be well sealed with a filler paint, plaster, or gypsum especially if the block is very porous. The critical frequency weakness of a masonry wall is usually in the mid-low frequency range. At higher frequencies, the solid path through the structure is a limitation. These effects can be overcome with a double masonry wall or a gypsum skin on one side of the wall. The double masonry wall is the best possible, but the two walls must not have any solid connections except at the perimeters. Special braces are available if necessary. A gypsum skin on one side of the wall with an air space can also provide a significant improvement for a single masonry wall. This gypsum skin must be over an air space, and sound absorbing material in the space helps. Furring can connect the gypsum and masonry, but flexibility in the furring helps. This air space does introduce a resonance and weakness. The air space must be at least 1.5 inches and preferably 3.5 inches if only one layer of gypsum is used. Otherwise, the resonant weakness may coincide with the critical frequency of the masonry.

The best gypsum walls use two separate sets of studs on separate base plates. The more gypsum, the better, but all gypsum must be on the outside of the walls, not inside between the studs. Adding gypsum inside actually reduces performance at low frequencies. Absorbing batts should be installed in at least one set of studs. Walls with about 1.25 inches of gypsum on each side and 8 inches space between these layers will usually test over STC 60. Such walls can test greater than STC 65 in laboratory tests where each side is well isolated from the other. Performance can be improved in practice by isolating the base plates from the floor. Most of the gypsum should be firecode rated for maximum density. To preserve the performance of these walls, electrical outlets on opposite sides must have at least two sets of studs and a full stud space between them. Shear bracing plywood if needed should be installed behind the gypsum and not inside between studs. If a layer of gypsum or other solid material must be inside the wall, it must be installed on only one set of studs and the spacing between base plates and thickness of the other studs maximized. Never build a wall with solid material on the inside surface of each set of studs.

A variation on the above wall uses studs staggered on a single base plate. This does not work as well since the air space is typically not as thick and a more effective connection exists through the common base plate. Care must be used to avoid packing the absorbing batts between the studs and the gypsum on the side not connected to the stud. This is ideally done using two thinner layers of absorber overlapped so only one thickness is between studs and gypsum.

If only a single set of studs is used, do not use solid wood studs or steel studs heavier than 25 gauge unless some resilient element is used to isolate the gypsum from the studs on one side. Light 25 gauge studs or wood studs with special built-in resilient elements are much better than heavier steel studs or solid wood studs, but not as good as studs with resilient point attachments. Point attachment methods include resilient channel and special resilient isolation clips to support hat channel. Resilient channel must not be heavier than 25-gauge and should have slots 3 inches long with solid sections one inch long in the web. It should be installed to the studs with the free edge for attachment of the gypsum upward, and the slots aligned with the studs. The resilient clips can provide better results because they increase the thickness of the air space and reduce the number of attachment points to the studs.