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NCMA TEK

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NOISE CONTROL WITH CONCRETE MASONRY

TEK 13-2A
Sound (2007)

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INTRODUCTION

Sound control is an important design consideration in most buildings. Sound control involves two important properties: sound transmission and sound absorption, as depicted in Figure 1. The *International Building Code* (IBC, refs. 1, 2) contains minimum requirements for sound transmission in certain situations (see *Sound Transmission Class Ratings of Concrete Masonry Walls*, TEK 13-1B, ref. 3). However, the IBC does not contain minimum requirements for sound absorption., although proper control of sound reflected back into the room is a very important design function in many buildings as well, such as concert halls, gymnasiums, places of assembly, rooms containing loud equipment.

Concrete masonry is an ideal noise control material for both properties: it can act as a barrier by diffusing incident noise over a wide range of frequencies; and it can be an effective sound absorption material for absorbing noise generated within a room. This TEK discusses the sound absorption and sound transmission properties of concrete masonry, and provides general design guidance to help provide a good acoustic environment.

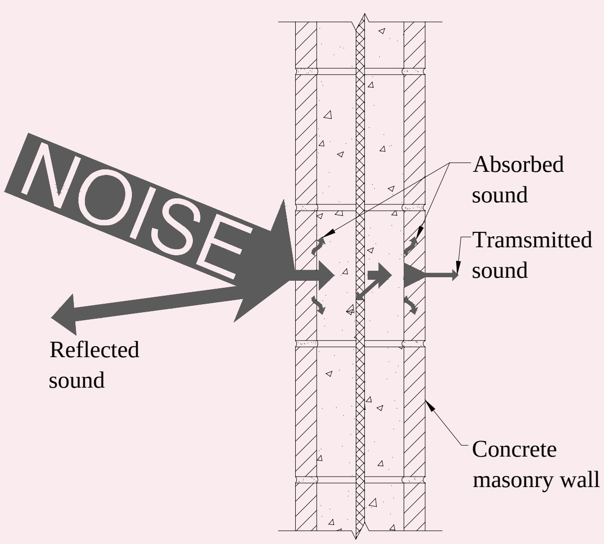


Figure 1—Sound Attenuation Characteristics of Concrete Masonry

MAXIMIZING SOUND ABSORPTION

Sound absorption control involves minimizing sound reflection, so that the noise generated within the space is not echoed back into the space. Sound absorption is most important in applications like assembly areas or concert halls. The extent of control provided by a particular surface depends on that surface's ability to absorb rather than reflect sound waves. This ability is estimated by the surface's sound absorption coefficient: an indication of its sound absorbing efficiency. A surface which can theoretically absorb 100% of incident sound would have a sound absorption coefficient of 1. Similarly, a surface capable of absorbing 45% of incident sound has a sound absorption coefficient of 0.45.

Because the sound absorption coefficient typically varies with the frequency of the incident sound, the sound absorption coefficients measured at various frequencies are averaged together to produce an overall absorption coefficient. *Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method*, ASTM C 423 (ref. 4) prescribes the test method and calculations. Traditionally, sound absorption has been reported in terms of the noise reduction coefficient (NRC), determined by taking a mathematical average of the sound absorption coefficients obtained at frequencies of 250, 500, 1,000 and 2,000 Hertz. More recently, the Sound Absorption Average (SAA) has been added to ASTM C 423. Although the SAA is very similar to NRC, it is determined by averaging the sound absorption coefficients obtained at the twelve one-third octave bands from 200

Table 1—Approximate Noise Reduction Coefficients

NRC for Unpainted CMU Wall				
		Surface texture:		
		Coarse	Medium	Fine
Lightweight concrete masonry		0.50	0.45	0.40
Normal weight concrete masonry		0.28	0.27	0.26
NRC for Painted Lightweight CMU Wall				
		Surface texture:		
Paint, application	Coats	Coarse	Medium	Fine
Any, sprayed	1	0.45	0.41	0.36
	2	0.40	0.36	0.32
Oil, brushed	1	0.40	0.36	0.32
	2	0.23	0.21	0.18
Latex, brushed	1	0.35	0.32	0.28
	2	0.23	0.21	0.18
Cement, brushed	1	0.20	0.18	0.16
	2	0.05	0.05	0.04
NRC for Painted Normal Weight CMU Wall				
		Surface texture:		
Paint, application	Coats	Coarse	Medium	Fine
Any, sprayed	1	0.25	0.24	0.23
	2	0.22	0.22	0.21
Oil, brushed	1	0.22	0.22	0.21
	2	0.13	0.13	0.12
Latex, brushed	1	0.20	0.19	0.18
	2	0.13	0.13	0.12
Cement, brushed	1	0.11	0.11	0.10
	2	0.03	0.03	0.03

through 2,500 Hz. ASTM C 423 requires that both NRC and SAA be reported. Experience in the concrete masonry industry has shown that the new SAA values and the old NRC values vary little and generally are within 1 or 2 percentage points of each other.

Sound absorption values depend primarily on the surface texture and porosity of the material under consideration. More porous and open-textured surfaces are able to absorb more sound and, hence, have a higher value. This is reflected in the concrete masonry NRC values listed in Table 1. Note that painting a concrete masonry wall closes small surface openings, and hence decreases the wall's sound absorption value.

MINIMIZING SOUND TRANSMISSION

Sound insulation, as between dwelling units, is accomplished by designing walls to minimize sound transmission. For this purpose, effectiveness primarily depends on wall weight, rather than on surface texture. In general, the heavier a concrete masonry wall is, the more effectively it will block sound transmission.

The sound transmission class (STC) rating provides an indication of how effectively a given wall prevents sound transmission across a range of frequencies. STC ratings for concrete masonry walls are determined using *Standard Method for Determining the Sound Transmission Class Rating for Masonry Walls*, TMS 0302 (ref. 5). TEK 13-1B, *Sound Transmission Class Ratings of Concrete Masonry Walls*, contains a complete discussion on determining STC ratings, applicable building code requirements, as well as tabulated values for various concrete masonry walls.

WALL SELECTION

When used for noise control, concrete masonry walls should be evaluated for both surface texture and density. Sound transmission is reduced by using heavier walls, but may be increased by using units with a very open surface texture. Transmission loss characteristics of unpainted, open-textured units can be increased by plastering or painting, although this will also result in a corresponding reduction in the sound absorption (SAA or NRC) of the block.

In some cases, the designer may wish to use both the transmission loss and absorption properties of concrete masonry to advantage. For example, using open textured units in a cavity wall with back plastering on the inside face of one or both wythes provides sound absorption on both sides of the wall as well as sound transmission reduction. Another option for providing both effective sound absorption and sound transmission loss is the use of acoustical concrete masonry units, such as those shown in Figure 2. These units typically have an opening molded into the face shell, to allow sound energy to readily enter the masonry cells. The cells are designed to incorporate systems such as metal septa and/or fibrous fillers to dissipate the sound energy and minimize sound transmission.

DESIGN AND CONSTRUCTION

Early in the design, a detailed noise survey should be conducted to determine the outside noise level and the anticipated background noise level in the various building areas. A building layout can then be developed which will help reduce noise transmission from one area to another. Effective sound

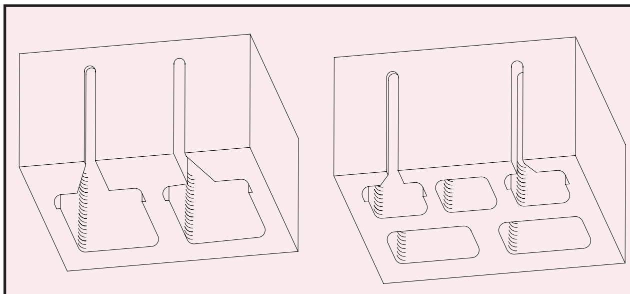


Figure 2—Examples of Acoustical Concrete Masonry Units (viewed from bottom)

control depends on proper layout and wall selection as well as good construction techniques.

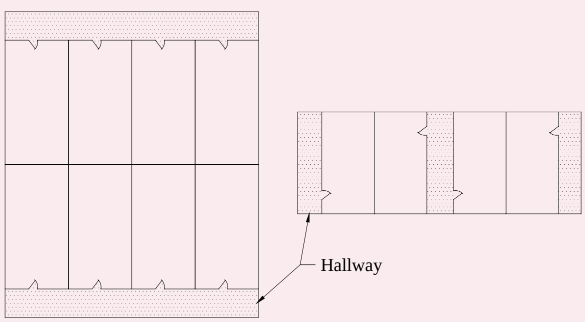
Sound will be easily transmitted through any opening in a wall. An improperly fitted corridor door is a prime source of sound leakage, as well as openings around ducts, piping and electrical outlets which are improperly fitted or sealed. A crack just 0.007 in. (0.178 mm) wide along the top of a $12^1/_2$ ft (3.8 m) wall will allow as much transmitted sound as a 1 in.^{2} (645 mm^2) hole. Hence, it is very important to seal all cracks, joints and gaps to maintain the acoustical integrity of the wall.

Building design and layout can also impact the building's acoustic effectiveness. Planning early in the design process can help alleviate potential problem areas farther down the line. For example, individual spaces should be planned to minimize common walls whenever possible (see Figure 3), and to place adjacent spaced such that quieter areas (such as bedrooms) abut each other, and noisy areas (such as kitchens) abut similar noisy areas (see Figure 4).

When considering building layout, also note that sound travels most effectively in straight lines. Every time sound energy changes direction, some of it is absorbed and some diffused, hence reducing the amount that is transmitted. For example, Figure 5 shows that simply offsetting hallway doors can decrease the sound transmitted from one space to another through the doors. Separating windows will have a similar effect (see Figure 6).

Any wall penetration will potentially transmit sound. Therefore, plan to eliminate penetration whenever possible (see Figure 7). When unavoidable, partial wall penetrations such as electrical boxes should be completely sealed with joint sealant**.** Through-wall openings should be completely sealed, after first filling gaps with foam, cellulose fiber, glass fiber, ceramic fiber or mineral wool**.** See *Sound Transmission Class Ratings of Concrete Masonry Walls*, TEK 13-1B, for a more complete discussion of minimizing sound transmission through wall penetrations.

Finally, building heating and cooling ducts offer a potential noise pathway throughout a building. There are many ways to absorb or dissipate this noise, including acoustic linings and splitters to help break up and disperse the sound energy (see Figure 8). Any changes to the building's ductwork will also potentially impact heating and cooling distribution. These effects should be considered during the HVAC system design.



(a) Cubicle plan: each unit has up to three common walls

(b) In-line plan (preferred): each unit has only one common wall

Figure 3—Plan the Building Layout to Minimize Common Walls

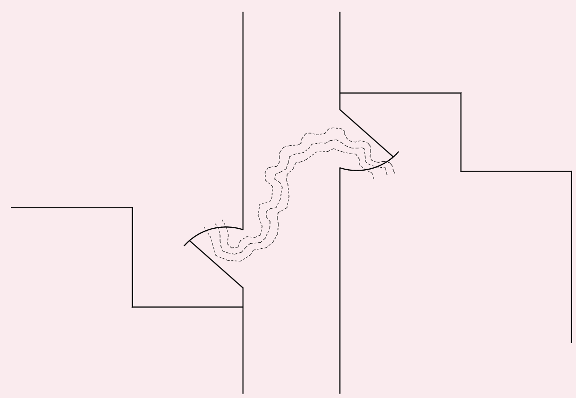


Figure 5—Offset Doors Opening onto the Same Hallway

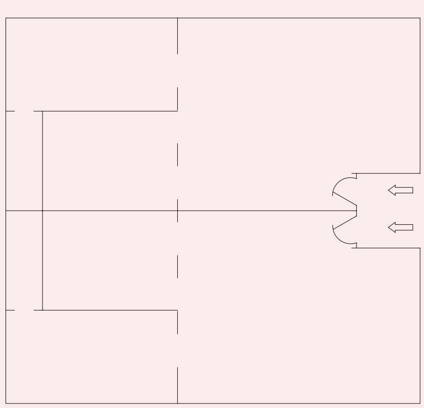


Figure 4—Use Mirror Floor Plans

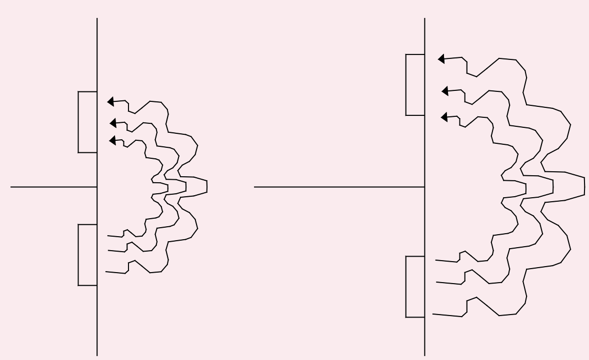
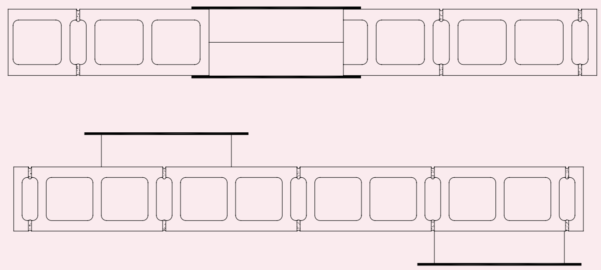


Figure 6—Move Windows Farther Away from Common Wall



Wall-mounted medicine cabinets preclude the need to penetrate the common wall in multi-family housing. Offsetting full or partial wall penetrations also reduces noise transmission.

Figure 7—Minimize Wall Penetrations

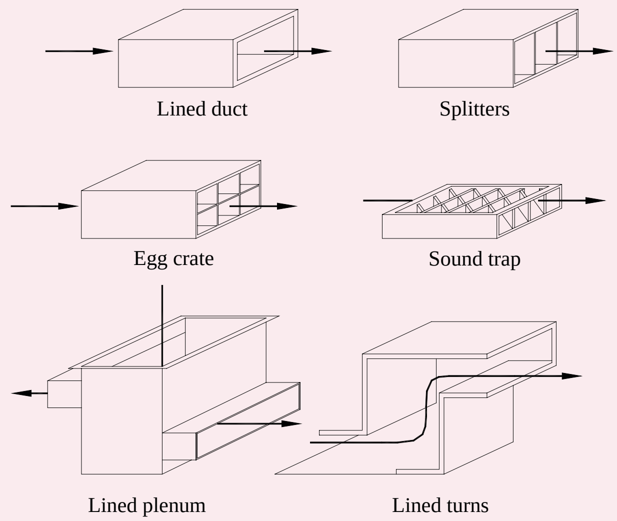


Figure 8—Acoustic Controls for Heating and Cooling Ducts

REFERENCES

1. *2003 International Building Code. International Code Council*, 2003.
2. *2006 International Building Code. International Code Council*, 2006.
3. *Sound Transmission Class Ratings of Concrete Masonry Walls*, TEK 13-1B. National Concrete Masonry Association, 2007.
4. *Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method*, ASTM C 423-07. ASTM International, 2007.
5. *Standard Method for Determining the Sound Transmission Class Rating for Masonry Walls*, TMS 0302-07. The Masonry Society, 2007.

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