CONCRETE MASONRY & HARDSCAPES ASSOCIATION

Provided By:

OUTDOOR-INDOOR TRANSMISSION CLASS OF CONCRETE MASONRY WALLS

INTRODUCTION

Providing a quality indoor acoustic environment is becoming a higher priority in many cases; particularly in urban environments where noise from traffic and other outside sources can be a significant distraction, especially in schools, homes and the workplace. Concrete masonry walls provide excellent noise control due to their ability to effectively block airborne sound transmission over a wide range of frequencies.

The ability of a wall to insulate a building interior from outdoor noise can be indicated by the wall's outdoor-indoor transmission class (*OITC*), with higher *OITC* values indicating better sound insulation.

OITC is one rating system available to help compare the acoustic performance of various wall systems. Others include the sound transmission class (*STC*) and the noise reduction coefficient (*NRC*). Both *OITC* and *STC* indicate a wall's ability to block the transmission of sound from one side of the wall to the other. *OITC* differs from the *STC* rating in that the *OITC* was developed specifically to indicate transmission of noise from transportation sources. *STC* was developed primarily for indoor noise sources, such as human speech. Unlike *OITC* and *STC*, *NRC* indicates the ability of a wall to absorb sound, which is useful for controlling sound reverberations within a room.

This TEK presents *OITC* values for a variety of common concrete masonry exterior walls. *STC* and *NRC* values for concrete masonry walls can be found in TEK 13-01D, *Sound Transmission Class Ratings for Concrete Masonry Walls*, and TEK 13-02A, *Noise Control With Concrete Masonry* (refs. 1, 2), respectively.

OUTDOOR-INDOOR TRANSMISSION CLASS

The *OITC* is a rating intended for exterior building facades, and is an estimate of a wall's or window's ability to reduce typical transportation noise. It is determined in accordance with ASTM E1332, *Standard Classification for Rating Outdoor-Indoor Sound Attenuation* (ref. 3). E1332 presents a standard procedure to calculate *OITC* based on tested sound transmission loss (*TL*) across the wall or wall element at specific frequencies from 80 to 4,000 Hz. These TL values are measured either in the laboratory or in the field using ASTM E90, *Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*, or ASTM E966, *Standard Guide for Field Measurements of Airborne Sound Attenuation of Building Facades and Facade Elements* (refs. 4, 5).

OITC is calculated using these tested *TL* values along with the sound spectrum of a reference sound source. This reference sound spectrum is an average of typical spectra from three transportation noise sources: aircraft takeoff, freeway and railroad passby. The reference sound spectrum is A-weighted to better correlate to human hearing (A-weighting is a frequency response adjustment that accounts for the changes in human hearing sensitivity as a function of frequency).

Although higher *OITC* values indicate more effective sound insulation from noises similar to the reference sound spectrum, it should be noted that the accuracy of the rating depends on

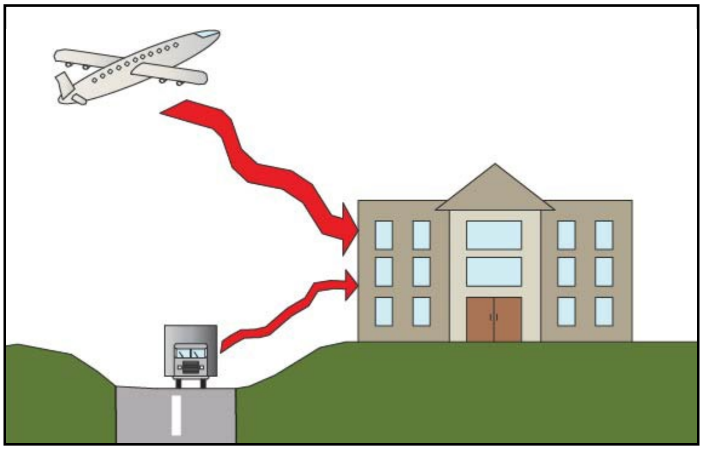

Figure 1—OITC Estimates Sound Insulation From Common Traffic Sources

the actual exterior noise spectrum and the surface area of the wall, as well as the acoustic performance of other building elements, such as windows and doors. The *OITC* is intended to be used to compare various facades, rather than as a predictor of performance.

The *OITC* can be applied to walls, doors, windows, or combinations thereof. As presented in this TEK, the *OITC* values apply to the masonry portion of the wall only, without windows or other openings.

CONCRETE MASONRY *OITC* VALUES

OITC Values Based on Test Data

Many ASTM E90 sound transmission loss tests have been performed on a wide variety of concrete masonry walls. *OITC* values for some of these walls have been calculated in accordance with ASTM E1332 from E90 test data, and are presented in Table 1. In general, for concrete masonry walls, heavier walls have higher *OITC* values.

Note that the ASTM E1332 *OITC* calculation requires transmission loss (*TL*) test data from 80 Hz to 4,000 Hz, while ASTM E90 test reports often do not include *TL* values at 80 Hz. Test reports which do include 80 Hz show that the *TL* value of concrete masonry walls at 80 Hz is typically about the same or higher than that at 100 Hz. For the purposes of this TEK, where *TL* values at 80 Hz were not reported, the 80 Hz *TL* was assumed equal to the 100 Hz *TL*.

OITC values can also be determined by field testing, using test data from ASTM E966, then calculated in accordance with E1332.

Estimated *OITC* in the Absence of Test Data

Ideally, *OITC* should be based on tested transmission loss values. In recognition that this data is not always available, however, the information in Figure 1 is presented as a tool to help designers estimate *OITC* values.

It has been well established (ref. 6) that the *STC* of concrete masonry walls is directly related to wall weight. Using this knowledge and the calculated *OITC* values in Table 1, a correlation between concrete masonry wall weight and *OITC* has been developed for walls at least 3 in. (76 mm) thick:

$$OITC = 14.7W^{0.290} \qquad \text{Eqn. 1}$$

$$[\text{SI: } OITC = 9.28W^{0.290}]$$

where W = the average wall weight based on the weight of the masonry units; the weight of mortar, grout and loose fill material in voids within the wall; and the weight of plaster, stucco and paint, psf (kg/m²). The weight of drywall is not included.

Table 1 contains calculated *OITC* values for various concrete masonry walls, based on Equation 1.

For multi-wythe walls where both wythes are concrete masonry, the weight of both wythes is used in Equation 1.

For multi-wythe walls having both concrete masonry and clay brick wythes, however, a different procedure must be used, because concrete and clay masonry have different acoustical properties. In this case, Equation 2, representing a best-fit relationship for clay masonry, must also be used. To determine a single *OITC* for the wall system, first calculate the *OITC* using both Equations 1 and 2, using the combined weight of both wythes, then linearly interpolate between the two resulting *OITC* ratings based on the relative weights of the wythes. Equation 2 is the *OITC* equation for clay masonry (ref. 1):

$$OITC = 17.4W^{0.224} \qquad \text{Eqn. 2}$$

$$[\text{SI: } OITC = 12.2W^{0.224}]$$

Tabulated wall weights for concrete masonry walls can be found in CMU-TEC-002-23, *Weights and Section Properties of Concrete Masonry Assemblies* (ref. 7).

For example, consider a masonry cavity wall with an 8-in. (203-mm) concrete masonry backup wythe (W = 33 psf, 161 kg/m²) and a 4-in. (102-mm) clay brick veneer (W = 38 psf, 186 kg/m²).

$$OITC \text{ (Eqn. 1)} = 14.7(33 + 38)^{0.29} = 50$$

$$STC \text{ (Eqn. 2)} = 17.4(33 + 38)^{0.224} = 45$$

Interpolating:

$$STC = 50(33/71) + 45(38/71) = 47$$

OITC REQUIREMENTS

Although not currently required by the *International Building Code* (ref. 8), designers sometimes include an *OITC* requirement in the construction documents, particularly for buildings close to railroads, airports and highways.

DESIGN AND CONSTRUCTION

In addition to transmission class values for walls, other factors also affect the acoustical environment of a building. Seemingly minor construction details can impact the acoustic performance of a wall. For example, screws used to attach gypsum wallboard to steel furring or resilient channels should not be so long that they contact the face of the concrete masonry substrate, as this contact area becomes an effective path for sound vibration transmission.

Through-wall openings, partial wall penetration openings and inserts, such as electrical boxes, as well as control joints should be completely sealed.

The reader is referred to TEK 13-01D, *Sound Transmission Class Ratings for Concrete Masonry Walls*, and TEK 13-02A, *Noise Control With Concrete Masonry* (refs. 1, 2) for more detailed information on the above as well as additional design and building layout considerations to help minimize sound transmission.

Table 1—Calculated *OITC* Ratings for Concrete Masonry Walls (ref. 6)

Nominal unit thickness, in. (mm)	Density, pcf (kg/m^3)	*OITC*[A]			
		Hollow unit	Grout-filled unit	Sand-filled unit	Solid unit
4 (102)	85 (1,362)	34	40[B]	38	38
	95 (1,522)	35	40[B]	39	39
	105 (1,682)	36	41[B]	40	40
	115 (1,842)	37	42[B]	40	41
	125 (2,002)	38	43[B]	41	42
	135 (2,162)	39	43[B]	42	43
6 (152)	85 (1,362)	36	46	43	43
	95 (1,522)	37	47	44	44
	105 (1,682)	38	48	45	45
	115 (1,842)	39	48	45	46
	125 (2,002)	40	49	46	48
	135 (2,162)	41	49	47	49
8 (203)	85 (1,362)	39	51	47	47
	95 (1,522)	40	51	48	48
	105 (1,682)	41	52	49	49
	115 (1,842)	42	53	49	51
	125 (2,002)	43	53	50	52
	135 (2,162)	44	54	51	53
10 (254)	85 (1,362)	41	54	51	50
	95 (1,522)	42	55	51	51
	105 (1,682)	44	56	52	53
	115 (1,842)	45	56	53	54
	125 (2,002)	46	57	54	55
	135 (2,162)	47	57	54	56
12 (305)	85 (1,362)	43	58	53	52
	95 (1,522)	44	58	54	54
	105 (1,682)	45	59	55	55
	115 (1,842)	46	60	56	57
	125 (2,002)	48	60	56	58
	135 (2,162)	49	61	57	60

[A] Based on: grout density of 140 lb/ft^3 (2,243 kg/m^3); mortar density of 130 lb/ft^3 (2,082 kg/m^3) sand density of 90 lb/ft^3 (1,442 kg/m^3); unit percentage solid from mold manufacturer's literature for typical units (4-in. (100-mm) 73.8% solid, 6-in. (150-mm) 55.0% solid, 8-in. (200-mm) 53.0% solid, 10-in. (250-mm) 51.7% solid, 12-in. (300-mm) 48.7% solid). Other unit configurations may have different *OITC* values. *OITC* values for grout-filled and sand-filled units assume the fill materials completely occupy all voids in and around the units. *OITC* values for solid units are based on all mortar joints solidly filled with mortar.

[B] Because of small core size and the resulting difficulty consolidating grout, these units are rarely grouted.

REFERENCES

1. *Sound Transmission Class Ratings for Concrete Masonry Walls*, TEK 13-01D, Concrete Masonry & Hardscapes Association, 2012.
2. *Noise Control With Concrete Masonry,* TEK 13-02A, Concrete Masonry & Hardscapes Association, 2007.
3. *Standard Classification for Rating Outdoor-Indoor Sound Attenuation,* ASTM E1332-10a. ASTM International, 2010.
4. *Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements*, ASTM E90-09. ASTM International, 2009.
5. *Standard Guide for Field Measurements of Airborne Sound Attenuation of Building Facades and Facade Elements,* ASTM E966-10e1. ASTM International, 2010.
6. *Standard Method for Determining The Sound Transmission Rating for Masonry Walls*, TMS 0302-12. The Masonry Society, 2012.
7. *Weights and Section Properties of Concrete Masonry Assemblies*, CMU-TEC-002-23, Concrete Masonry & Hardscapes Association, 2023.
8. 2003, 2006, 2009, and 2012 *International Building Code*. International Code Council, 2003, 2006, 2009, 2012.