1 — Scope

This Standard provides minimum requirements for rating masonry assemblies constructed using one or more masonry units complying with Section 5.1 for sound transmission class, *STC*, and outdoor-indoor transmission class, *OITC*. These ratings are for masonry assemblies in structures erected under the requirements of the legally-adopted building code of which this Standard forms a part. In areas without a legally-adopted building code, this Standard defines minimum acceptable methods to determine the *STC* and *OITC* ratings of masonry assemblies. All masonry dimensions referred to in this standard are nominal unless indicated otherwise.

2 — Reference Standards

Standards of ASTM International and The Masonry Society cited in this standard are listed below with their serial designations, including year of adoption or revision, and are declared to be part of this standard as if fully set forth in this document.

ASTM C33/C33M-18 – Specification for Concrete Aggregates

ASTM C34-17 – Specification for Structural Clay Loadbearing Wall Tile

ASTM C55-17 – Specification for Concrete Building Brick

ASTM C56-13(2017) – Specification for Structural Clay Nonloadbearing Tile

ASTM C62-17 – Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)

ASTM C73-17 – Specification for Calcium Silicate Brick (Sand-Lime Brick)

ASTM C90-16a – Specification for Loadbearing Concrete Masonry Units

ASTM C126-17 – Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units

ASTM C129-17 – Specification for Nonloadbearing Concrete Masonry Units

ASTM C212-17 – Specification for Structural Clay Facing Tile

ASTM C216-17a –Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)

ASTM C270-14a – Specification for Mortar for Unit Masonry

ASTM C331/C331M-17 – Specification for Lightweight Aggregates for Concrete Masonry Units

ASTM C476-18 – Standard Specification for Grout for Masonry

ASTM C516-08(2013)e1 – Specification for Vermiculite Loose Fill Thermal Insulation

ASTM C549-06(2012) – Specification for Perlite Loose Fill Insulation

ASTM C652-17a – Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)

ASTM C744-16 – Specification for Prefaced Concrete and Calcium Silicate Masonry Units

ASTM C920-14a – Specification for Elastomeric Joint Sealants

ASTM C1405-16 – Specification for Glazed Brick (Single Fired, Brick Units)

ASTM C1634-16 – Specification for Concrete Facing Brick

ASTM C1714/C1714M-16 – Specification for Preblended Dry Mortar Mix for Unit Masonry

ASTM E90-09(2016) – Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

ASTM E336-16a – Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings

ASTM E413-16 – Classification for Rating Sound Insulation

ASTM E966-18 – Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Facade Elements

ASTM E1332-16 – Classification for Rating Outdoor-Indoor Sound Attenuation

TMS 602-16 – Specification for Masonry Structures

3 — Notations

DSTC = the change in *STC* rating from a bare concrete masonry assembly (dB)

d = the thickness of a single furring space; where a furring space is provided on both sides of an assembly, d shall be taken equal to the thickness of one furring space layer, in. (mm)

FSTC = Field Sound Transmission Class (dB)

OITC = Outdoor-Indoor Transmission Class (dB)

STC = Sound Transmission Class (dB)

STL = Sound Transmission Loss (dB)

W = Average Assembly Weight per Surface Area, psf (kg/m^2)

4 — Definitions

Average assembly weight, W — The average assembly weight based on the weight of the masonry units, the weight of mortar, grout, loose fill material in voids within the assembly, and the weight of plaster, stucco, and paint. The weight of gypsum wallboard shall not be included.

Coarse textured – a relative term referring to the porosity of the matrix through the thickness of the masonry, which is related to the airflow through a masonry unit.

Field Sound Transmission Class, FSTC — Sound transmission class calculated using values of field transmission loss.

Outdoor-Indoor Transmission Class, OITC — A single-number rating calculated in accordance with ASTM E1332 using values of sound transmission loss.

Sound absorbing material - Fibrous materials, such as cellulose fiber, glass fiber, or rock wool insulation.

Sound Transmission Class, STC — A single-number rating calculated in accordance with ASTM E413 using values of sound transmission loss.

Sound Transmission Loss, STL — A measure equal to ten times the common logarithm of the ratio of the airborne sound power, in a specified frequency band, incident on the assembly to the sound power transmitted by the assembly and radiated on the opposite side of the assembly .

5 — Materials

5.1 Masonry Units

Masonry units shall comply with the requirements of one of the following standards: ASTM C34, ASTM C55, ASTM C56, ASTM C62, ASTM C73, ASTM C90, ASTM C126, ASTM C129, ASTM C212, ASTM C216, ASTM C652, ASTM C744, ASTM C1405, or ASTM C1634.

5.2 Mortar

Mortar shall comply with the requirements of ASTM C270 or ASTM C1714/C1714M.

5.3 Grout

Grout shall comply with the requirements of ASTM C 476.

5.4 Joint Sealants

Joint sealants shall comply with the requirements of ASTM C 920.

5.5 Loose Fill Materials

Loose fill materials used to fill voids in masonry construction shall comply with ASTM C33/C33M, ASTM C331/C331M, ASTM C516, or ASTM C549.

6 — Construction

Construction shall conform to the requirements of TMS 602 for concrete masonry and clay masonry and shall conform to the requirements of this Standard when applying the STC ratings of Section 7 or the OITC ratings of Section 8.

6.1 Sealing penetrations and joints

6.1.1 Through-wall and membrane penetrations shall be sealed with joint sealant, mortar, or grout. Prior to sealing around penetrations, the perimeter space behind the surface sealant shall be filled with foam, cellulose fiber, glass fiber, ceramic fiber, or mineral wool.

6.1.2 Movement joints and joints between the top of masonry assemblies and roof or floor assemblies shall be sealed with joint sealant. The space behind the sealant shall be filled with mortar, grout, foam, cellulose fiber, glass fiber, or mineral wool. Noncompressible filler materials shall not be used in movement or expansion joints of clay masonry assemblies or at the top of nonloadbearing partitions.

6.2 Surface coatings

Coarse-textured concrete masonry assemblies shall be covered on or both faces with gypsum wallboard attached directly to the surface or shall be sealed on one or both faces with at least one coat of acrylic latex, alkyd or cement based paint, plaster, or other suitable coating.

7 — Sound Transmission Class Ratings

The sound transmission class, *STC*, rating**s** of masonry assemblies shall be determined in accordance with Section 7.1, 7.2, or 7.3.

7.1 Laboratory testing

The *STC* rating**s** of masonry assemblies shall be determined based on laboratory testing of an assembly that is representative of the actual construction. Testing shall be conducted in accordance with the requirements of ASTM E90 and STC values calculated in accordance with ASTM E413.

7.2 Field testing

The *STC* rating**s** of field-evaluated masonry assemblies shall be conducted in accordance with the requirements of ASTM E336 and calculated in accordance with ASTM E413.

7.3 Calculation

7.3.1 Clay Masonry Construction

The *STC* ratings for clay masonry assemblies shall be determined in accordance with Eq. 1. The minimum nominal thickness of the clay masonry assembly shall not be less than 3 in. (76 mm).

$$STC = 19.6W^{0.230} \quad \text{Eq. 1.}$$

SI $STC = 13.6W^{0.230}$

7.3.2 Concrete Masonry Construction

The *STC* ratings for concrete masonry assemblies shall be determined in accordance with Eq. 2. The minimum nominal thickness of the concrete masonry assembly shall not be less than 4 in. (102 mm).

$$STC = 20.5W^{0.234} \quad \text{Eq. 2.}$$

SI $STC = 14.1W^{0.234}$

7.3.2.1 Effect of Gypsum Wallboard on *STC* Ratings of Concrete Masonry Assemblies When *STC* ratings are determined by Eq. 2, gypsum wallboard attached directly to the concrete masonry shall be assumed to not change the *STC* rating.

The change in the sound transmission class, *STC*, rating**s** for 1/2-in. (13 mm) or 5/8-in. (16 mm) thick gypsum wallboard attached to concrete masonry assemblies with furring shall be determined using Eq. 3, 4, 5, or 6 as appropriate. Where sound absorbing material is used, it shall fill the entire furring space. When gypsum wallboard is applied to both sides of the assembly, the specified thickness of the furring space, *d*, shall be identical on each side of the assembly.

For gypsum wallboard on one side of the assembly with no sound absorbing material in the furring space:

$$DSTC = 2.8d - 1.22 \quad \text{Eq. 3}$$

SI $DSTC = 0.11d - 1.22$

For gypsum wallboard on both sides of the assembly and no sound absorbing material in the furring spaces:

$$DSTC = 3.6d - 2.78 \quad \text{Eq. 4}$$

SI $DSTC = 0.14d - 2.78$

For gypsum wallboard on one side of the assembly with sound absorbing material in the furring space:

$$DSTC = 3.0d + 1.87 \quad \text{Eq. 5}$$

SI $DSTC = 0.12d + 1.87$

For gypsum wallboard on both sides of the assembly and sound absorbing material in the furring spaces:

$$DSTC = 11.2d - 7.37 \quad \text{Eq. 6}$$

SI $DSTC = 0.44d - 7.37$

7.3.3 Multi-Wythe Masonry Construction

The *STC* ratings for multi-wythe assemblies consisting of concrete masonry and clay masonry wythes shall be determined in accordance with Eq. 1 and Eq. 2 using the total weight of all wythes for the average assembly weight, *W*. The resulting *STC* rating shall be linearly interpolated between each independently calculated *STC* rating based on the relative weights of the two materials in the assembly.

8 — Outdoor-Indoor Transmission Class Ratings

The Outdoor-Indoor Transmission Class, *OITC*, ratings of masonry assemblies shall be determined in accordance with Section 8.1, 8.2, or 8.3.

8.1 Laboratory testing

The *OITC* ratings of masonry assemblies shall be determined based on laboratory testing of an assembly that is representative of the actual construction. Testing shall be conducted in accordance with the requirements of ASTM E90 and OITC values calculated in accordance with ASTM E1332.

8.2 Field testing

The *OITC* ratings of field-evaluated masonry assemblies shall be conducted in accordance with the requirements of ASTM E966 and calculated in accordance with ASTM E1332.

8.3 Calculation

8.3.1 Clay Masonry Construction

The *OITC* ratings for clay masonry assemblies shall be determined in accordance with Eq. 7. The minimum nominal thickness of the clay masonry assembly shall not be less than 3 in. (76 mm).

$$OITC = 17.4W^{0.224} \qquad \text{Eq. 7.}$$

$$\text{SI} \quad OITC = 12.2W^{0.224}$$

8.3.2 Concrete Masonry Construction

The *OITC* ratings for concrete masonry assemblies shall be determined in accordance with Eq. 8. The minimum nominal thickness of the concrete masonry assembly shall not be less than 4 in. (102 mm).

$$OITC = 14.7W^{0.290} \qquad \text{Eq. 8.}$$

$$\text{SI} \quad OITC = 9.28W^{0.290}$$

8.3.3 Multi-Wythe Masonry Construction

The *OITC* ratings for multi-wythe assemblies consisting of concrete masonry and clay masonry wythes shall be determined in accordance with Eq. 7 and Eq. 8 using the total weight of all wythes for the average assembly weight, *W*. The resulting *OITC* rating shall be interpolated between each independently calculated *OITC* rating based on the relative weights of the two materials in the assembly.

Commentary
Standard Method for Determining
Sound Transmission Ratings
for Masonry Assemblies
(TMS 0302-XX)

This commentary accompanies the Standard and provides an explanation of and justification for the requirements of the Standard. This commentary is not intended to be part of the Standard. The Standard is a concise statement of requirements and is intended to be adopted by reference in construction documents, building codes, and other standards. This commentary provides background information including illustrations and example applications of the requirements of the Standard and is not intended to be adopted by reference in other documents. The commentary is intended to assist the designer and other users of the Standard in applying the Standard and in understanding the basis for specific requirements of the Standard.

1 — Scope

Sound ratings of masonry assemblies are based on field or laboratory testing in accordance with standard test methods or by calculation. Performance of masonry assemblies in resisting sound transmission depends on the frequency and magnitude of the sound, detailing practices to mitigate the transmission of sound, and the sound transmission loss characteristics of the masonry assembly.

Sound transmission loss, *STL*, is the decrease or attenuation in sound energy expressed in decibels (dB) of air borne sound as it passes through an assembly. Sound transmission loss is determined in accordance with ASTM E90 at specified frequencies. In general, *STL* for masonry assemblies increases as the frequency of the sound increases.

Sound transmission class, *STC*, is determined by ASTM E413. It provides an estimate of the performance of an assembly in certain common sound insulation applications. Although *STC* is a convenient index to relative sound transmission, the *STL* spectra should be studied in order to meet particular sound transmission requirements.

Outdoor-indoor transmission class, *OITC*, is determined in accordance with ASTM E1332. ASTM E1332 presents a standard procedure to determine *OITC* based on measured sound transmission loss, *STL*, across an assembly at frequencies from 80 to 4,000 Hz. *OITC* is calculated using tested *STL* values and 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 with human hearing (A-weighting is a frequency response adjustment that accounts for the changes in human hearing sensitivity as a function of frequency).

2 — Reference Standards

No commentary.

3 — Notations

No commentary.

4 — Definitions

The weight of the gypsum wallboard is not to be included in the calculated sound rating of the assembly. The effect of gypsum wallboard, a cavity and sound absorbing insulation is considered as an adjustment to the STC rating of the bare masonry assembly. The air space between the gypsum wallboard can resonate somewhat like the skin of a drum and actually reduce the STC rating of the assembly as reflected by Equations 3 and 4 and Commentary Table 7.3-5. When gypsum wallboard is attached directly to the surface of coarse-textured concrete masonry, it provides the same benefit for sound transmission loss as for sealing the surface but provides no additional benefit due to its mass (ref. 7).

5 — Materials

No commentary.

6 — Construction

6.1 Sealing penetrations and joints

Noncompressible materials, including mortar and grout, should not be used for fillers for expansion joints and the top of nonloadbearing partition walls. Where roof or floor construction is metal deck, use special shape foam filler strips to seal the top of the assembly.

The type and shape of penetrations and joints may greatly affect the sound transmission loss of an assembly. (See Figure 6.2.1 for common examples.) This variation is difficult to quantity and so sealing all penetrations, joints, and other holes, cracks or voids not otherwise specified with the appropriate sealant is of utmost importance (see Figure 6.2.2).

To act as an effective sound barrier, partitions should be carried to the underside of the floor or roof. The joint between the underside of a floor or roof and top of a partition should provide for slab deflection and be sealed against sound transmission. Fire-rated assemblies are also required to meet fire resistive construction requirements including fire stopping of through penetrations and fire-resistive sealing materials in accordance with the legally-adopted building code. Fire safety provisions of the legally adopted building code may limit the type(s) of material(s) permitted to be used in joints of fire rated construction.

If roof or floor construction is metal deck rather than concrete, it is not feasible to use joint sealants alone to seal the top of masonry assemblies because of the shape of the deck flutes. For fire and smoke containment assemblies, safing insulation is used instead of foam filler strips.

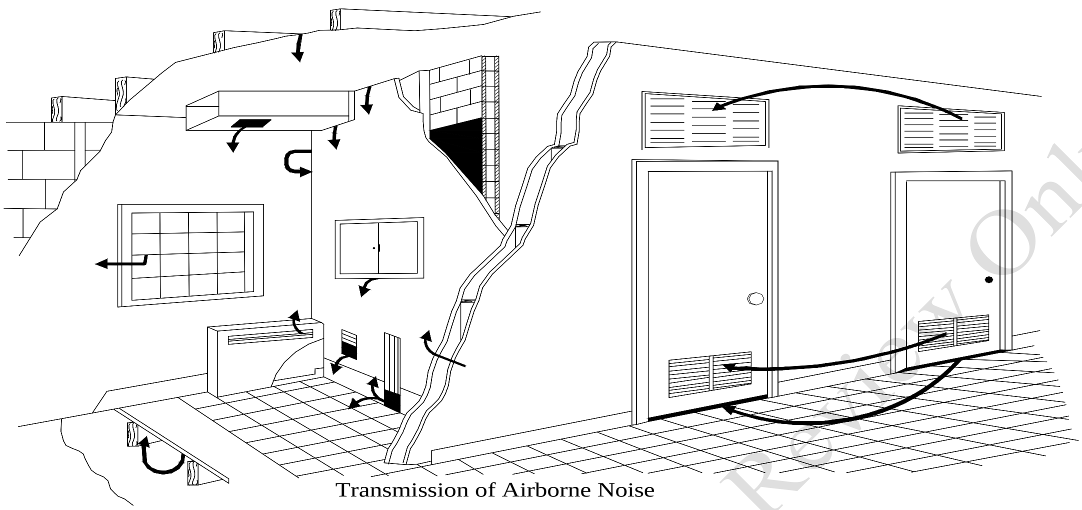

Figure 6.2.1 — Acoustical Leaks (Ref. 1)

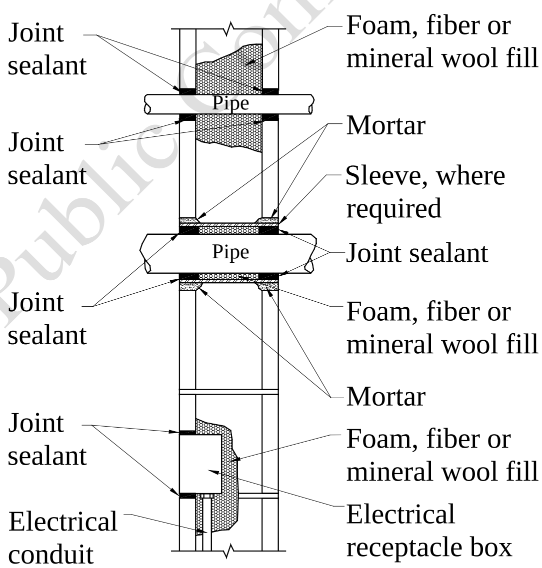

Figure 6.2.2 — Sealing Around Penetrations and Fixtures

6.2 Surface coatings

Assemblies constructed of fine and medium textured concrete masonry units and fired clay masonry assemblies do not require additional surface treatments, however, assemblies constructed using coarse textured concrete masonry units, which may allow airborne sound to enter the assembly, require a surface treatment to seal at least one surface of the assembly. Coatings of acrylic latex, alkyd or cement-based paint, or of plaster are acceptable. Other coatings are also acceptable provided they effectively seal the surface of coarse textured concrete masonry units.

There is substantial discussion about the effect of porosity of concrete masonry units in Reference 7. This reference included both lightweight aggregate and what was termed very porous (wood aggregate) blocks in their study for the purposes of comparison. The report indicated that leakage of sound was somewhat related to the airflow resistivity of the units and that sealing of coarse-textured units on only one surface was effective. Normal weight blocks showed little or no improvement in sound transmission resistivity after sealing. Texture as used in this context does not refer to the surface roughness of the block but the matrix of the mix used in manufacturing the block.

The committee reasoned that, in most cases, sound rated assemblies with coarse-textured units would have a surface treatment on at least one surface, which is subsequently required by Section 6.2. Therefore, the data for unsealed coarse-textured masonry units was not included in developing the concrete masonry equations for calculated sound transmission ratings.

1

7 — Sound Transmission Class Ratings

7.1 Laboratory testing

Representative masonry materials need not be from the same manufacturer.

7.2 Field testing

No commentary.

7.3 Calculation

7.3.1 Clay Masonry Construction

Sound transmission class, *STC*, data of clay masonry assemblies (Ref. 2) are plotted against average assembly weight, *W*, in Figure 7.3-1. The equation for the curve best fitting the data is $STC = 19.6W^{0.230}$ $(STC = 13.6W^{0.230})$ with a correlation coefficient of 0.885. Figure 7.3-1 also shows that a power curve fit is better than a linear fit of the data. Table 7.3-1 lists the reported STC values of the various clay masonry assemblies tested. Table 7.3-3 lists various calculated STC values for clay masonry assemblies.

7.3.2 Concrete Masonry Construction

STC data of concrete masonry assemblies (Ref. 3, 4, 5, and 6) are plotted against average assembly weight, *W*, in Figure 7.3-2. The equation for the curve best fitting the data is $STC = 20.5W^{0.234}$ $(STC = 14.1W^{0.234})$ with a correlation coefficient of 0.849. Figure 7.3-2 also shows that a power curve fit is better than a linear fit of the data. Table 7.3-2 lists the reported STC values of the various clay masonry assemblies tested. Table 7.3-4 lists various calculated STC values for concrete masonry assemblies.

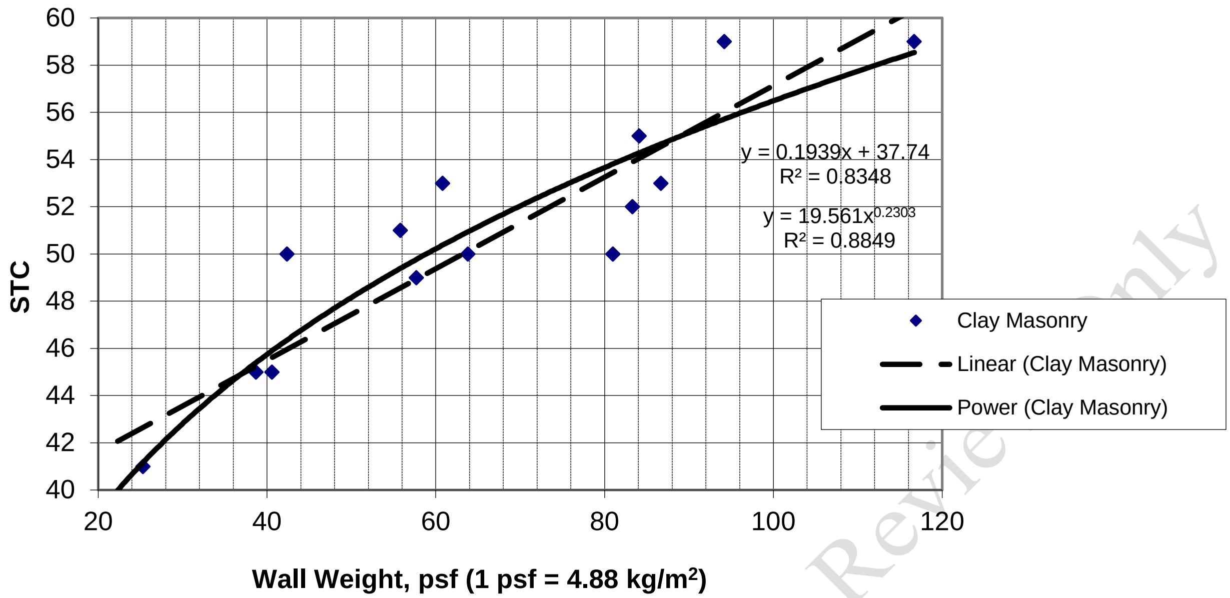

Figure 7.3-1 — Curve Fit for Clay Masonry

Table 7.3-1 — Data for Clay Masonry (Ref. 2)

Weight psf, (kg/m^2)	Reported *STC*
22.3 (109)	39
25.3 (124)	41
38.7 (189)	45
40.6 (198)	45
42.4 (207)	50
55.8 (272)	51
57.7 (282)	49
60.8 (297)	53
63.8 (311)	50
81 (395)	50
83.3 (407)	52
84.1 (411)	55
86.7 (423)	53
94.2 (460)	59
116.7 (570)	59

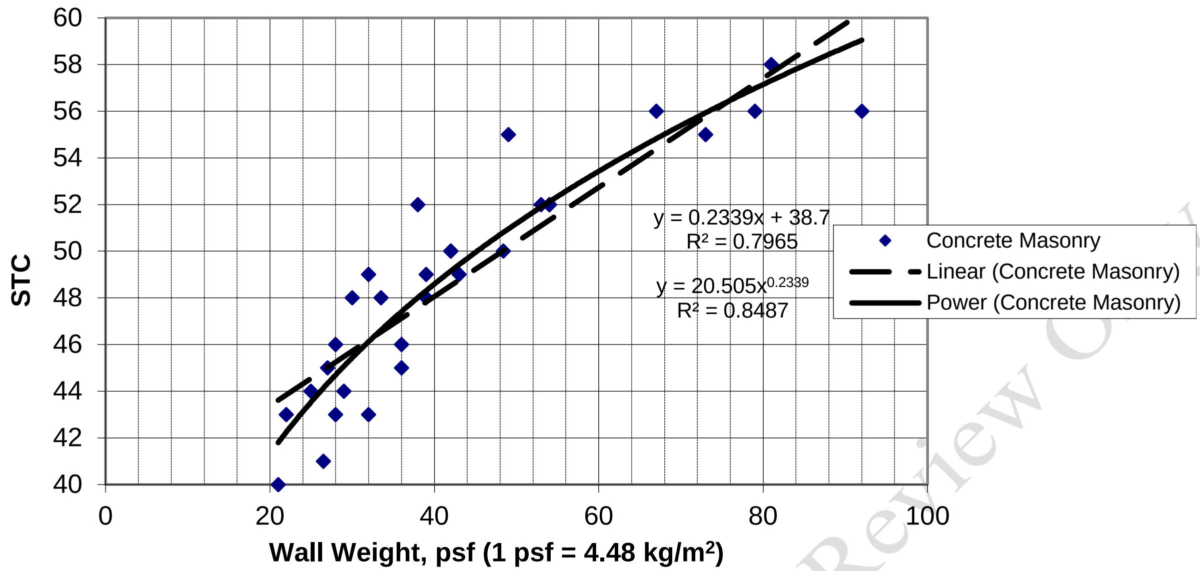

Figure 7.3-2 — Curve Fit for Concrete Masonry

Table 7.3-2— Data for Concrete Masonry (Ref. 3, 4, 5, & 6)

Weight Class	**Finish**	**Weight** psf, (kg/m^2)	***STC***	**Reference**
Lightweight	Bare	21 (103)	40	Ref. 4
Lightweight	Bare	25 (122)	44	Ref. 4
Lightweight	Bare	36 (176)	45	Ref. 4
Lightweight	Bare	39 (190)	49	Ref. 4
Lightweight	Bare	43 (210)	49	Ref. 4
Lightweight	Paint	22 (107)	43	Ref. 4
Lightweight	Paint	28 (137)	46	Ref. 4
Lightweight	Paint	36 (176)	46	Ref. 4
Lightweight	Paint	32 (156)	43	Ref. 3
Lightweight	Paint	73 (356)	55	Ref. 4
Lightweight	Plaster	28 (137)	43	Ref. 3
Lightweight	Plaster	30 (146)	48	Ref. 4
Lightweight	Plaster	32 (156)	49	Ref. 4
Lightweight	Plaster	38 (186)	52	Ref. 4
Lightweight	Plaster	42 (205)	50	Ref. 5
Lightweight	Plaster	49 (239)	55	Ref. 4
Lightweight	Plaster	54 (264)	52	Ref. 4
Lightweight	Plaster	67 (327)	56	Ref. 4
Lightweight	Plaster	79 (386)	56	Ref. 4
Lightweight	Plaster	81 (395)	58	Ref. 4
Normal Weight	Paint	29 (142)	44	Ref. 4
Normal Weight	Paint	33.5 (164)	48	Ref. 4
Normal Weight	Paint	39 (190)	48	Ref. 4
Normal Weight	Plaster	27 (132)	45	Ref. 5
Normal Weight	Plaster	42 (205)	50	Ref. 4
Normal Weight	Plaster	92 (449)	56	Ref. 4
Normal Weight	Plaster	54 (264)	52	Ref. 5
Normal Weight	Bare	26.5 (129)	41	Ref. 4
Normal Weight	Bare	48.4 (236)	50	Ref. 6
Normal Weight	Bare	53 (259)	52	Ref. 4

Table 7.3-3 — Calculated *STC* Ratings for Clay Masonry Assemblies[1]

Nominal Assembly Thickness[2] in. (mm)	Hollow Units		Grout Filled		Sand Filled		Solid Units	
	Weight psf, (kg/m^2)	*STC*	Weight psf, (kg/m^2)	*STC*	Weight psf, (kg/m^2)	*STC*	Weight psf, (kg/m^2)	*STC*
3 (75)	Not applicable		Not applicable		Not applicable		30 (146)	43
4 (100)	20 (98)	39	38 (186)	45	32 (156)	43	35 (171)	44
6 (150)	32 (156)	43	63 (308)	51	50 (244)	48	55 (269)	49
8 (200)	42 (205)	46	86 (420)	55	68 (332)	52	75 (366)	53
10 (250)	53 (259)	49	109 (532)	58	86 (420)	55	95 (464)	56
12 (300)	62 (303)	51	132 (644)	60	104 (508)	57	115 (561)	58

[1] Based on the smallest specified unit dimension minus the specified tolerance, Clay density of 120 lbs/ft^3 (586 kg/m^3); Grout density of 144 lbs/ft^3 (703 kg/m^3), Sand density of 100 lbs/ft^3 (488 kg/m^3). *STC* values for grout filled and sand filled units assume the materials completely occupy all void areas in and around the units. *STC* values for solid units are based on bed and head joints solidly filled with mortar.

[2] Dimensions in this column reflect equivalent nominal metric unit sizes as opposed to direct SI conversion.

Table 7.3-4—Calculated *STC* Values for Concrete Masonry Assemblies[1]

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	80 (1281)	40	45	43	43
6 (150)	80 (1281)	41	51	48	48
8 (200)	80 (1281)	44	54	51	51
10 (250)	80 (1281)	46	58	54	54
12 (300)	80 (1281)	47	60	57	56

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	85 (1362)	40	45	44	44
6 (150)	85 (1362)	42	51	48	48
8 (200)	85 (1362)	44	55	52	52
10 (250)	85 (1362)	46	58	55	55
12 (300)	85 (1362)	48	61	57	57

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	90 (1442)	41	45	44	44
6 (150)	90 (1442)	42	51	49	49
8 (200)	90 (1442)	45	55	52	52
10 (250)	90 (1442)	47	58	55	55
12 (300)	90 (1442)	48	61	57	58

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	95 (1522)	41	46	44	45
6 (150)	95 (1522)	43	51	49	49
8 (200)	95 (1522)	45	55	52	53
10 (250)	95 (1522)	48	58	55	56
12 (300)	95 (1522)	49	61	58	58

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	100 (1602)	42	46	45	45
6 (150)	100 (1602)	43	52	49	50
8 (200)	100 (1602)	46	56	53	54
10 (250)	100 (1602)	48	59	56	56
12 (300)	100 (1602)	49	61	58	59

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	105 (1682)	42	46	45	46
6 (150)	105 (1682)	44	52	50	50
8 (200)	105 (1682)	46	56	53	54
10 (250)	105 (1682)	49	59	56	57
12 (300)	105 (1682)	50	62	58	60

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	110 (1762)	43	47	45	46
6 (150)	110 (1762)	44	52	50	51
8 (200)	110 (1762)	47	56	53	55
10 (250)	110 (1762)	49	59	56	58
12 (300)	110 (1762)	51	62	59	60

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	115 (1842)	43	47	46	46
6 (150)	115 (1842)	45	52	50	51
8 (200)	115 (1842)	47	56	54	55
10 (250)	115 (1842)	50	59	57	58
12 (300)	115 (1842)	51	62	59	61

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	120 (1922)	43	47	46	47
6 (150)	120 (1922)	45	53	50	52
8 (200)	120 (1922)	48	57	54	56
10 (250)	120 (1922)	50	60	57	59
12 (300)	120 (1922)	52	62	59	61

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	125 (2002)	44	48	46	47
6 (150)	125 (2002)	45	53	51	52
8 (200)	125 (2002)	48	57	54	56
10 (250)	125 (2002)	50	60	57	59
12 (300)	125 (2002)	52	63	60	62

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	130 (2082)	44	48	47	48
6 (150)	130 (2082)	46	53	51	53
8 (200)	130 (2082)	49	57	55	57
10 (250)	130 (2082)	51	60	57	60
12 (300)	130 (2082)	52	63	60	62

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	135 (2162)	45	48	47	48
6 (150)	135 (2162)	46	53	51	53
8 (200)	135 (2162)	49	57	55	57
10 (250)	135 (2162)	51	60	58	60
12 (300)	135 (2162)	53	63	60	63

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	140 (2243)	45	48	47	48
6 (150)	140 (2243)	46	54	51	54
8 (200)	140 (2243)	49	58	55	57
10 (250)	140 (2243)	52	61	58	61
12 (300)	140 (2243)	53	63	60	63

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	145 (2323)	45	49	48	49
6 (150)	145 (2323)	47	54	52	54
8 (200)	145 (2323)	50	58	55	58
10 (250)	145 (2323)	52	61	58	61
12 (300)	145 (2323)	54	64	61	64

Nominal Unit Size[2] in. (mm)	Density pcf (kg/m^3)	*STC*			
		Hollow Unit	Grout Filled	Sand Filled	Solid Units
4 (100)	150 (2403)	46	49	48	49
6 (150)	150 (2403)	47	54	52	54
8 (200)	150 (2403)	50	58	56	58
10 (250)	150 (2403)	53	61	59	62
12 (300)	150 (2403)	54	64	61	64

[1] Based on grout density of 140 lb/ft^3 (2243 kg/m^3), sand density of 90 lb/ft^3 (1442 kg/m^3), mortar density of 130 lb/ft^3 (2082 kg/m^3). Percentage solid of units used from mold manufacturers' literature for typical masonry 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). *STC* values for grout filled and sand filled units assume the materials completely occupy all void areas in and around the units. *STC* values for solid units are based on bed and head joints solidly filled with mortar.

[2] Dimensions in this column reflect equivalent metric unit sizes as opposed to direct SI conversions.

7.3.2.1 Effect of Gypsum Wallboard on *STC* Ratings of Concrete Masonry Assemblies

The effect of gypsum wallboard attached directly to the surface of normal weight concrete masonry without a furring space has very little effect on the sound transmission class (*STC*) rating of the assembly. Gypsum wallboard directly attached to lightweight concrete masonry generally improves the *STC* rating by partially sealing of the surface. The more porous the masonry, the better the improvement in *STC* ratings. The amount of improvement is not quantifiable and therefore is not included in the calculated *STC* rating procedure. (Ref. 7 & 8).

Significant increases in *STC* ratings in a concrete masonry assembly can be achieved by adding gypsum wallboard and sound insulation in the furring space. Three factors govern the amount of improvement in *STC*:

- The method of support. The best method of support for the gypsum wallboard is the use of independent studs that have no direct connection to the concrete masonry. Resilient metal furring may also be used by itself or in combination with wood furring.
- The depth of the furring space (distance between the gypsum wallboard and the concrete masonry surfaces).
- The use of sound absorbing material in the furring space. (Ref. 7)

Mass-air-mass resonance at low frequencies and narrow furring spaces can cause the STC ratings to drop, particularly if that condition exists on both sides of the concrete masonry assembly. Under these conditions vibrational energy transfers from the gypsum board through the air space to the assembly more effectively than it does through the bare concrete masonry assembly. Table 7.3-5 presents the results of Eqs. 3 through 6 for various furring spaces with and without sound-absorbing material in the furring space.

Currently, there is no test data documenting the performance of gypsum wallboard over clay masonry assemblies. As such, the calculation procedures only address the impact of gypsum wallboard over concrete masonry assemblies.

7.3.3 Multi-Wythe Masonry Construction

The amount of acoustical testing on multi-wythe assemblies containing wythes of concrete masonry and clay masonry is limited. Much higher *STC* values can be achieved by using materials other than wire ties to connect the two wythes, varying the cavity depth and the type of insulation used in the cavity (Ref. 6).

For multi-wythe walls constructed of both concrete masonry and clay masonry units, the determination of the STC requires the use of both Eq. 1 and Eq. 2 from Section 7.3 based on the total combined assembly weight and then linearly interpolating between the two calculated values based on the relative assembly weight of each material. For example, consider a masonry cavity wall with an 8 in. (203 mm) concrete masonry backup having an installed weight of 55 lb/ft^2 (269 kg/m^2) and a 4 in. (102 mm) clay masonry veneer having an installed weight of 35 lb/ft^2 (171 kg/m^2).

Total Assembly Weight = 55 + 35 = 90 lb/ft^2 (439 kg/m^2)

Calculated STC by Equation 1 = $(19.6)(90)^{0.230} = 55.2$

Calculated STC by Equation 2 = $(20.5)(90)^{0.234} = 58.8$

Linearly Interpolated STC Based on Relative Assembly Weight

$= (55.2)(35/90) + (58.8)(55/90)$

$= 21.5 + 35.9 = 57.4$

Table 7.3-5—Change in *STC* Using the Furring Space Depth Indicated and a Single Layer of Gypsum Wallboard

Furring Space Condition	Sides	Furring Space, in. (mm)							
		0.5 (13)	0.75 (19)	1.0 (25)	1.5 (38)	2.0 (64)	2.5 (64)	3.0 (76)	3.5 (89)
No sound-absorbing material in the furring space	One	0.2	0.9	1.6	3.0	4.4	5.8	7.2	8.6
	Both	-1.0	-0.1	0.8	2.6	4.4	6.2	8.0	9.8
Furring space filled with sound-absorbing material*	One	3.4	4.1	4.9	6.4	7.9	9.4	10.9	12.4
	Both	-1.8	1.0	3.8	9.4	15.0	20.6	26.2	31.8

*Fibrous materials, such as cellulose fiber, glass fiber or rock wool insulation, are good materials for absorbing sound; closed-cell materials, such as expanded polystyrene, are not, as they do not significantly absorb sound.

8 — Outdoor-Indoor Transmission Class Ratings

8.1 Laboratory testing

Representative masonry materials need not be from the same manufacturer.

8.2 Field testing

No commentary.

8.3 Calculation

Many ASTM E90 sound transmission loss tests have been performed on a wide variety of concrete masonry assemblies. Outdoor-Indoor Transmission Class, *OITC* values for some of these assemblies have been calculated in accordance with ASTM E1332 from E90 test data, and are presented in Table 8.3-2. In general, for masonry assemblies, heavier assemblies have higher *OITC* values. Note that the ASTM E1332 *OITC* calculation requires transmission loss, *STL*, test data from 80 Hz to 4,000 Hz, while ASTM E 90 test reports often do not include *STL* values at 80 Hz. Test reports that do include 80 Hz show that the *STL* value of masonry assemblies at 80 Hz is typically about the same or higher than that at 100 Hz. For the purposes of this Standard, where *STL* values at 80 Hz were not reported, the 80 Hz *STL* was assumed equal to the 100 Hz *STL*.

OITC data of clay masonry assemblies (Ref. 2) are plotted against assembly weight, *W*, in Figure 8.3-1. The equation for the curve best fitting the data is $OITC = 17.4\ W^{0.224}$ ($OITC = 12.2\ W^{0.224}$) with a correlation coefficient of 0.8453.

OITC data of concrete masonry assemblies (Ref. 3, 4, 5, and 6) are plotted against average assembly weight, *W*, in Figure 8.3-2. The equation for the curve best fitting the data is $OITC = 14.7W^{0.290}$ ($OITC = 9.28W^{0.290}$) with a correlation coefficient of 0.8024.

Section 8 does not include options for assessing the impact of gypsum wallboard on the calculated OITC rating of a masonry assembly. Given the lack of available research data, it is unknown as to whether the OITC values would increase, decrease, or remain unaffected by the presence of gypsum wallboard. Users should consider the relative benefits of adding gypsum wallboard to exterior walls when OITC is a design consideration.

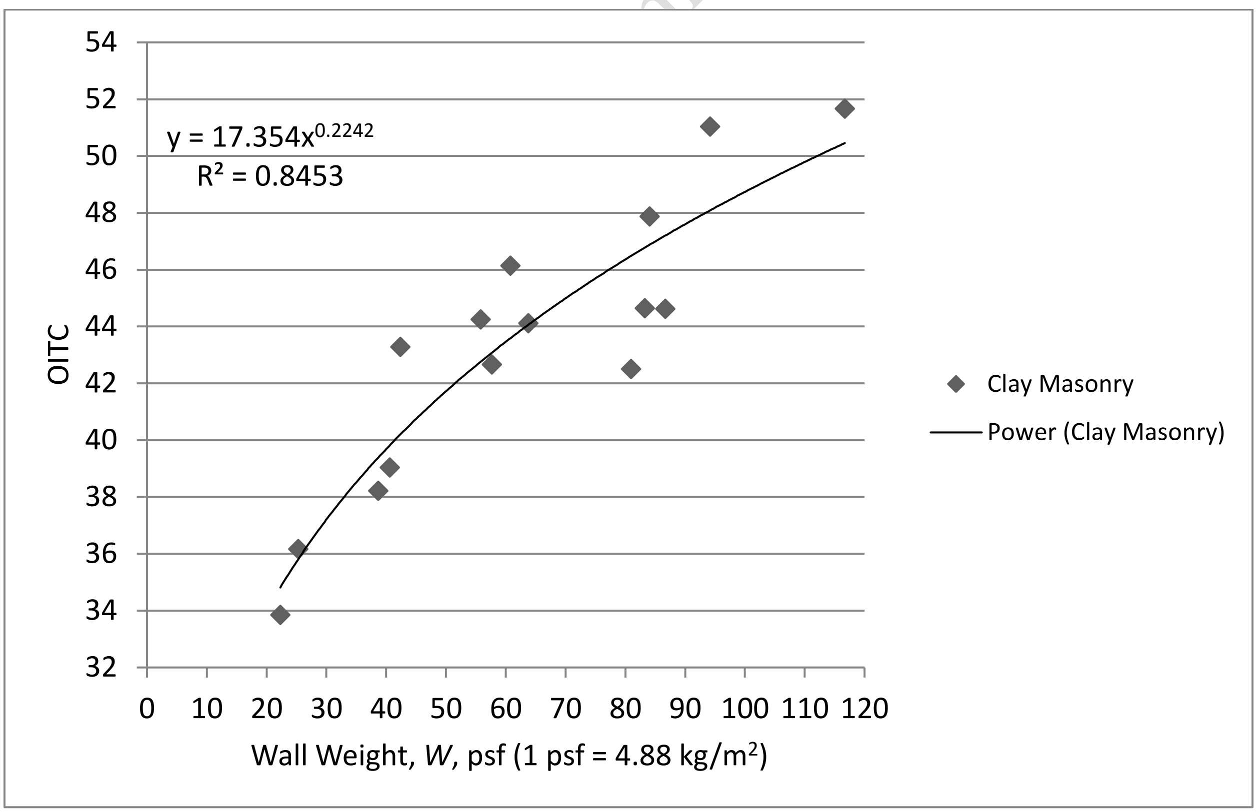

Figure 8.3-1 — *OITC* Curve Fit for Clay Masonry

Table 8.3-1— *OITC* Data for Clay Masonry (Ref. 2)

Weight psf, (kg/m^2)	***OITC***
22.3 (109)	34
25.3 (124)	36
38.7 (189)	38
40.6 (198)	39
42.4 (207)	43
55.8 (272)	44
57.7 (282)	43
60.8 (297)	46
63.8 (311)	44
81 (395)	43
83.3 (407)	45
84.1 (411)	48
86.7 (423)	45
94.2 (460)	51
116.7 (570)	52

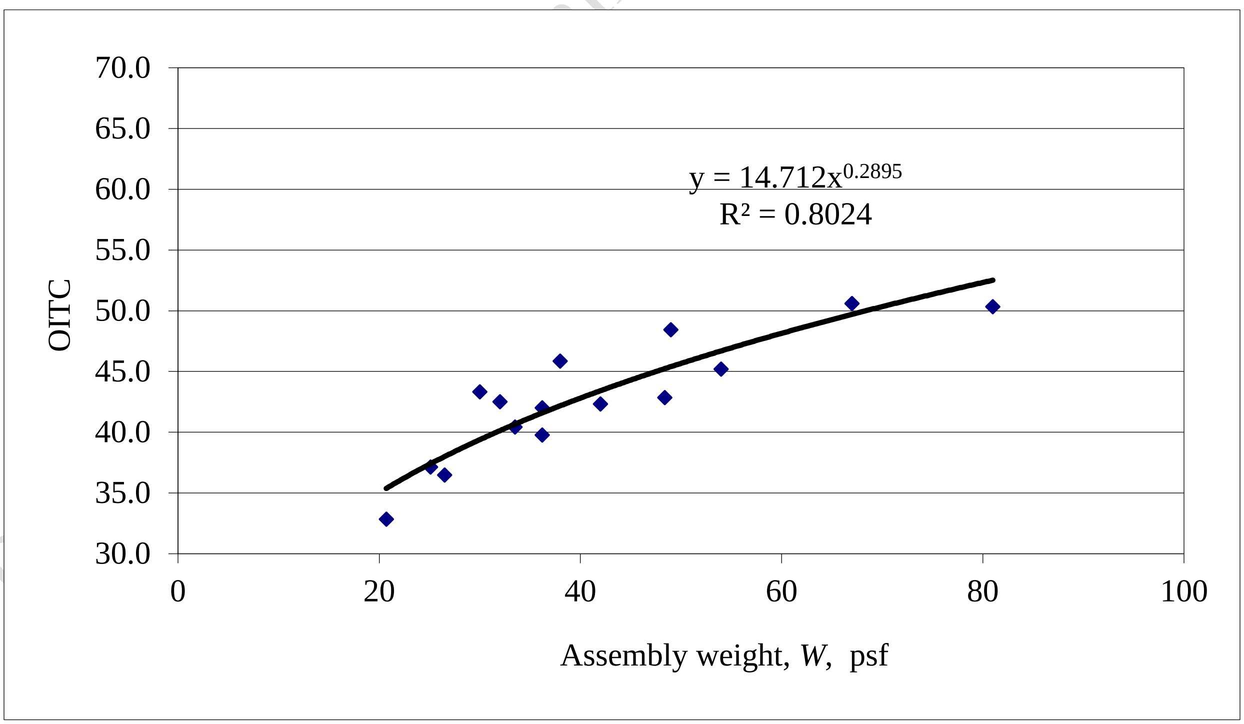

Figure 8.3-2 — *OITC* Curve Fit for Concrete Masonry

Table 8.3-2— *OITC* Data for Concrete Masonry (Ref. 4 & 6)

Weight Class*	Finish**	Weight psf, (kg/m^2)	*OITC*	Reference
L	0	20.7 (101)	32	Ref. 4
N	1	26.5 (129)	36	Ref. 4
N	2	32.0 (156)	42	Ref. 4
N	2	42.0 (205)	42	Ref. 4
L	2	36.2 (177)	43	Ref. 4
L	0	25.1 (123	37	Ref. 4
L	2	54.0 (264)	45	Ref. 4
L	0	36.2 (177)	39	Ref. 4
N	1	33.5 (164)	40	Ref. 4
L	1	36.2 (177)	42	Ref. 4
N	0	48.4 (236)	42	Ref. 6
L	2	38.0 (186)	45	Ref. 4
L	2	67.0 (327)	50	Ref. 4
L	2	49.0 (239)	48	Ref. 4
L	2	81.0 (395)	50	Ref. 4

*Weight class
L=Lightweight
N=Normal weight

**Finish:
0=bare
1=paint
2=plaster

References

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3. "Sound Transmission Class Ratings for Concrete Masonry Walls," *NCMA TEK*, 13-1, National Concrete Masonry Association, Herndon, VA, 1990.

4. *A Guide to Selecting Concrete Masonry Walls for Noise Reduction*. National Concrete Masonry Association, TR81, Herndon, VA, 1970.

5. *Sound Transmission Loss Through Concrete and Concrete Masonry Walls*. Portland Cement Association, Skokie, IL, 1978.

6. *Sound Transmission Loss Measurements on 190 and 140 mm Single Wythe Concrete Block Walls and on 90 mm Cavity Block Walls*, Report for Ontario Concrete Block Association. National Research Center of Canada Report No. CR-5588.1, 1989.

7. *Controlling Sound Transmission through Concrete Block Walls*, Construction Technology Update No. 13. National Research Council of Canada, 1998.

8. *Sound Transmission Loss Measurements Through 190 mm and 140 mm Blocks with Added Drywall and Through Cavity Block Walls*, Internal Report No. 586. National Research Council of Canada, 1990.