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Concrete Block Insulating Systems

Subject: Sound Transmission Through KORFIL Insulated Concrete Masonry Walls

Reference: 1) National Concrete Masonry Association Information Data Sheet TEK 13-1, dated 1990

2) Sinclair-Koppers Co.
Application Manual Section 6--Acoustical Uses--Dylite

Based on the above referenced data, it appears an improvement of 10% to 15% would be possible in the Sound Transmission Class (STC) of 8 and 12 inch walls with the use of KORFIL.

Since the STC range of 8 inch walls varies from 40 to 48 depending on wall weight while the STC range of 12 inch walls varies from 42 to 50 depending again on wall weight, they are already classified as walls where loud speech is approaching a murmur even without the use of KORFIL. Placing 3/8" thick Dylite on either side of a standard stud wall can improve the STC rating of that wall by 29%. In my opinion it is safe to assume adding approximately 2" of expanded polystyrene to the inside of blocks should reduce sound transmission through the cores of blocks over the normal voice range by about 9 Db.

Important points to consider.

1) Both 8" and 12" walls without KORFIL are classified as "difficult to hear normal speech through". A coat of paint or plaster can improve these walls by about 3 to 5 Db.
2) We have no data on sound transmission other than voice. Actual sound transmission tests would have to be run to determine the actual acoustical improvement with KORFIL for high frequency sounds (music for example).
3) KORFIL will not improve the impact transmission of sound through wall sections.

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SOUND TRANSMISSION CLASS RATINGS FOR CONCRETE MASONRY WALLS

Key Words: Sound Transmission Class (STC), Sound Transmission Loss (STL), sound levels, frequencies, cycles per second (cps), hertz (HZ), decibels (dB), vibration

INTRODUCTION

Unwanted noise is a major distraction, both in the home as well as the work environment. With each technological advance, more and more different types of noise generating machinery and appliances are finding their way into our everyday lives. This unwanted noise is not only disconcerting, but in many cases may also produce permanent injury to hearing when exposure is for prolonged periods of time, depending upon the intensity of the sound.

Two important elements of sound are frequency and pressure. Frequency is a measure of the number of vibrations or cycles per second (cps). One cycle per second is defined as a hertz (HZ). The measurement of pressure is in decibels (dB). For each 20 decibel increase in sound there is a corresponding tenfold increase in pressure. The human ear has the unique ability to reduce its sensitivity as the pressure increases. Therefore, while a 10 decibel increase in sound results in a threefold increase in pressure, the loudness sensation to the ear is only doubled.

The following provides an indication of the decibel as a measure of sound intensity.

Decibels	Sound
140	Jet plane takeoff
130	Threshold of discomfort
120	Riveting
110	Thunder - sonic boom
100	Hard rock band
90	Power lawnmower
80	Pneumatic jackhammer
70	Noisy office
60	Average radio
50	Normal conservation
40	Quiet street
30	Quiet conversation
20	Whisper at 4 ft.
10	Normal breathing
3	Threshold of audibility

Sounds are generated by vibrating objects. The vibrations are transmitted by contact with air, or other mediums, and are carried forward in waves. The speed at which sound travels through a medium depends upon both the density and the elasticity of the medium.

All solid materials have a natural frequency of vibration. If the frequency of a solid is at or near the frequency of the sound which strikes it, the solid will vibrate in sympathy with the sound, and the sound will be re-generated on the opposite side. This is true for all solids, including walls and partitions. The effect is especially noticeable when the wall or partition is light or thin. Conversely, the vibration is effectively stopped if the partition is of heavy, rigid material. Then the natural cycle of vibration will be relatively slow, and only sounds of low frequency will cause sympathetic vibration.

The human ear can perceive sounds as low as 16 cycles per second to as high as 20,000 cycles per second. However, it is most sensitive to sounds between 500 and 5000 cycles. For human voices speaking in conversational tones, a frequency of approximately 500 cycles per second is assumed.

Because of its mass and rigidity, concrete masonry is especially effective in reducing the transmission of unwanted sound. This is just one of its many attributes which makes it a most desirable building material.

Sound Transmission Class

Sound transmission class (STC) is a single-figure rating derived in a prescribed manner from sound transmission loss values. The rating provides an estimate of the performance of the partition in certain common sound insulation problems.

The STC of a wall is determined by comparing its transmission loss curve with a set of standard curves, or contours. The standard curve is superimposed over a plot of the sound transmission loss curve (Figure 1) and shifted upward or downward relative to the test curve until some of the measured TL values of the test specimen fall below those of the STC contour and the following conditions are fulfilled:

1. The sum of the deficiencies (deviations below the contour) shall not be greater than 32 dB, and

2. The maximum deficiency at a single test point shall not exceed 8 dB.

SOUND TRANSMISSION CLASS RATING FOR CONCRETE MASONRY WALLS

1.0 - Scope

These provisions cover requirements for sound transmission class (STC) rated concrete masonry walls and supplement the concrete masonry requirements of the general building code.

1.1 The STC rating of concrete masonry walls shall be determined based on testing representative wall assemblies in the laboratory in accordance with the requirements of ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions, and ASTM E 413, Classification for Sound Rating Insulation, or by calculation in accordance with the requirements of Section 8.0.

2.0 - Notations

FSTC = Field Sound Transmission Class
STC = Sound transmission class
w = Wall weight, psf
w_{req} = Required wall weight, psf

3.0 - Definitions

decibel, dB - the term used to identify ten times the common logarithm of the ratio of two like quantities proportional to power or energy.

field sound transmission class, FSTC - sound transmission class calculated using values of field transmission loss.

sound transmission class, STC - a single-number rating using values of sound transmission loss. It provides an estimate of the performance of a partition in certain common sound insulation problems.

sound transmission loss, TL - *of a partition, in a specified frequency band,* the decibel difference between the airborne sound power incident on the partition to the sound power transmitted by the partition and radiated on the other side.

wall weight - the weight of the masonry partition including any core fill, surface coatings, or coverings. The weight of cavity walls shall be calculated as the sum of the weights of the wythes.

4.0 - Materials

Materials used in the construction shall conform to the following ASTM specifications.

Masonry Units:

ASTM C 55, Standard Specification for Concrete Building Brick; ASTM C 73, Standard Specification for Calcium Silicate Face Brick (Sand-Lime Brick); ASTM C 90 Standard Specification for Load-Bearing Concrete Masonry Units; ASTM C 129, Standard Specification for Non-Loadbearing Concrete Masonry Units, ASTM C 744, Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units

Mortar:

ASTM C 270, Standard Specification for Mortar for Unit Masonry

Grout:

ASTM C 476, Standard Specification for Grout for Reinforced and Nonreinforced Masonry

Joint Sealants:

ASTM C 920, Standard Specification for Elastomeric Joint Sealants

5.0 - Construction

Construction shall be in accordance with the requirements of the general building code and this section.

5.1 Placing Mortar and Units

5.1.1 Hollow units shall be placed so that the face shells of bed joints are fully mortared and head joints are mortared a minimum distance from each face equal to the face shell thickness of the unit.

5.1.2 Solid units shall be placed with full bed and head joints such that mortar fills the joints from one face of the unit to the opposite face.

5.1.3 Holes, cracks, and voids in the masonry shall be filled.

5.2 Sealing Openings and Joints

5.2.1 Through penetration openings to accommodate pipes, air ducts, electrical outlets, etc., shall be completely sealed. Prior to sealing around openings, gaps shall be filled with foam, cellulose fiber, glass fiber, or mineral wool in accordance with Figure 3.

5.2.2 Electrical outlets and other fixtures installed in masonry walls shall be sealed to prevent airborne sound from entering the wall in accordance with Figure 3.

5.2.3 Control joints and joints between intersecting walls shall be sealed in accordance with one of the methods illustrated in Figure 4.

5.2.4 Joints between the top of walls and roof or floor assemblies shall be sealed. The joint space behind the sealant shall be filled with mortar, grout, foam, cellulose fiber, glass fiber, or mineral wool.

5.3 Surface Sealants

5.3.1 All walls shall be sealed with acrylic, oil, or cement based paints or plaster; or other suitable sealants.

6.0 Quality Assurance

The work shall be inspected for compliance with these requirements.

6.1 Acceptance - walls complying with these requirements shall be accepted. Walls which fail to meet one or more of these requirements shall be brought into compliance or may be accepted provided the FSTC rating determined in accordance with ASTM E 413 equals or exceeds the required field STC rating.

7.0 - Minimum Wall Thickeness

The minimum nominal thickness of walls shall be 4 inches.

8.0 - Calculated STC Ratings

8.1 The calculated sound transmission class rating of a concrete masonry wall system shall be determined in accordance with Equation 1.

$$STC = 21.6(w)^{0.2} \qquad \text{Eqn. 1}$$

8.2 For a given STC, the required weight of the wall system shall be determined in accordance with Equation 2.

$$w_{req} = (STC / 21.6)^{4.4} \qquad \text{Eqn. 2}$$

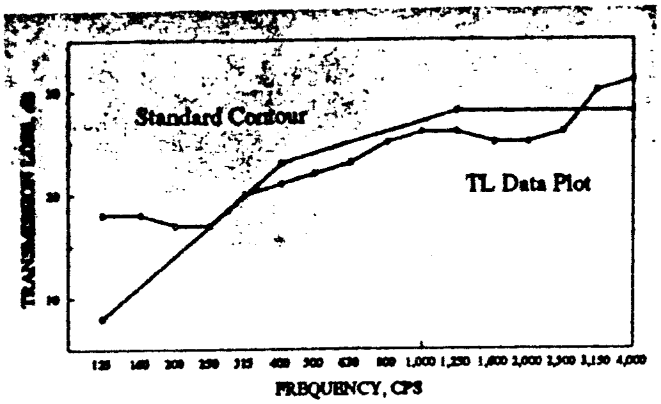

Figure 1 Example of STC Determination

When the contour is adjusted to the highest value that meets the above criteria, the sound transmission class is taken to be the transmission loss value, measured in decibels (dB), corresponding to the intersection of the standard contour and the 500 cycle per second (cps) frequency line.

Design and Construction

In addition to STC values for walls, there are other factors that have an effect on the acoustical environment of a building. Outside noise levels need to be considered. Low background noise levels, such as exist in rural areas, may indicate the need for partition walls to have a higher STC requirement. Another item that is important to noise insulation is wall layout. In apartment construction, an in-line arrangement, where each apartment will have only one common wall, is preferred. "Mirror-plan" arrangements will generally result in quieter areas, such as bedrooms being located adjacent to each other, and noisy areas, such as kitchens, abutting each other. Door and window arrangement may also have an effect on the acoustical environment. Locating apartment doors so that they are not directly opposite each other will diffuse a portion of noise that would otherwise be able to transmit directly across a hall. Windows in exterior walls should be located as far away from common walls as possible in order to help diffuse noise that may travel from one window to another.

Openings placed in common walls, such as electrical fixtures, plumbing pipes, ducts, and medicine cabinets, are a potential source for noise leaks. Figures 3 and 4 of this TEK illustrate possible methods to control noise penetration through proper detailing and construction.

Building Code Requirements

The model building codes all have similar requirements regulating sound transmission control for partitions that separate adjacent units in multi-family dwellings and similar partitions that separate dwelling units from public areas, service areas, or commercial facilities. In the BOCA Code, and the Appendix of the Standard Building Code, this requirement is that all partitions serving the above purpose shall have a sound transmission class of not less than 45 dB for air-borne noise when tested in accordance with ASTM E90. The Appendix of the Uniform Building Code establishes a lower limit of 50 dB for the same applications.

Sound Transmission Class of Concrete Masonry

Kodaras Acoustical Laboratories (KAL) was commissioned to conduct sound transmission loss tests on walls ranging in weight from 22 pounds per square foot to 79 pounds per square foot. Surfaces of the walls were sealed on one or both sides with paint, while others were plastered. The STC values of these walls were then determined in accordance with ASTM E 413, Standard Classification of Sound Transmission Class.

Table 1 Summary of STC Data of Concrete Masonry Walls

No.	Test Designation		Wall Weight lbs./sq. ft.	STC dB
1	KAL	1379-5-72	22	43
2	KAL	1709-74	28	43
3	KAL	933-2-70	28	46
4	KAL	1379-3-72	29	44
5	KAL	369-5-66	30	46
6	KAL	359-7-66	30	48
7	KAL	365-3-66	32	43
8	KAL	1379-1-72	39	48
9	KAL	1144-2-71	43	49
10	KAL	1144-3-71	53	52
11	KAL	1023-2-71	73	55
12	KAL	1023-9-71	79	56

Figure 2 shows a plot of the data obtained as a result of these tests. A curve of best fit was then determined. As can be seen from the curve, a direct relationship exists between the weight of a concrete masonry wall and the sound transmission class. This makes it possible to determine within a reasonable degree of accuracy the STC value which may be obtained from concrete masonry construction. Conversely, for a given STC value, the required weight of the concrete masonry wall may also be determined.

Further tests on companion walls have indicated the effect of adding gypsum board to the surface of the walls. The results of these tests indicate an increase of approximately 2 points to the STC value of the walls. An additional increase may be obtained if the gypsum board is mounted on resilient channels.

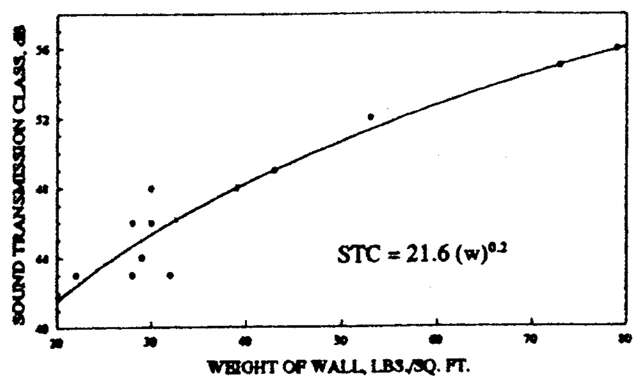

Figure 2 Wall Weight vs. STC

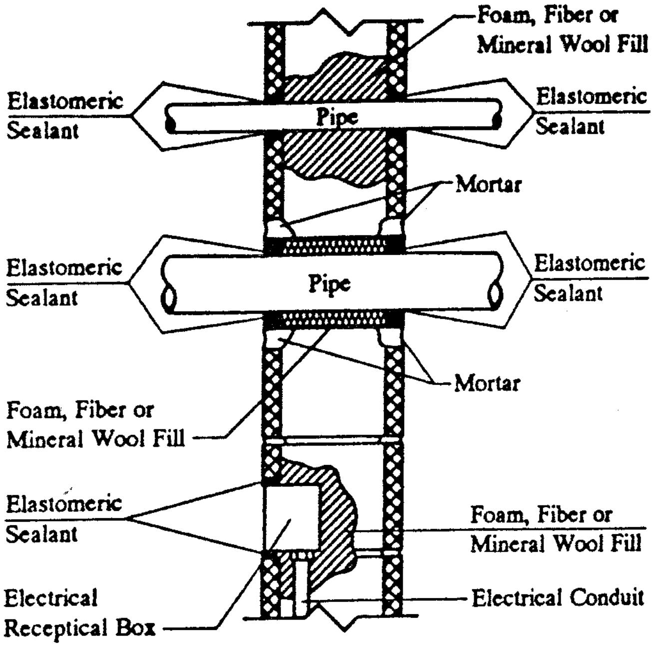

Figure 3 Sealing Around Penetrations and Fixtures

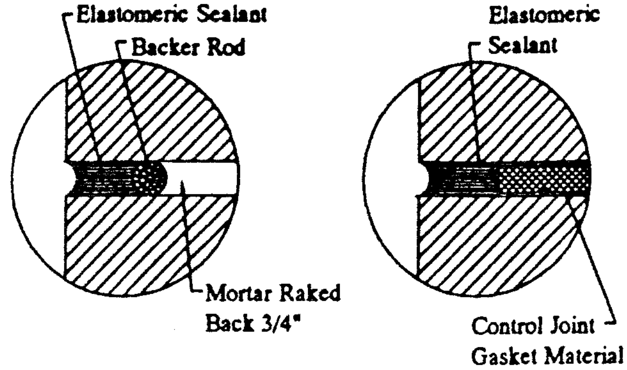

Figure 4 Sealing Wall Intersections and Control Joints

References:

(1) ASTM E 90 Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions

(2) ASTM E 413 Standard Classification of Sound Transmission Class

(3) Noise Control in Buildings, National Research Council of Canada, 1987

(4) Kodaras Acoustical Laboratories

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SOUND TRANSMISSION CLASS RATINGS FOR CONCRETE MASONRY WALLS

Please make the following corrections as indicated to the equation in Figure 2 on Page 2, and Equations 1 and 2 on Page 3.

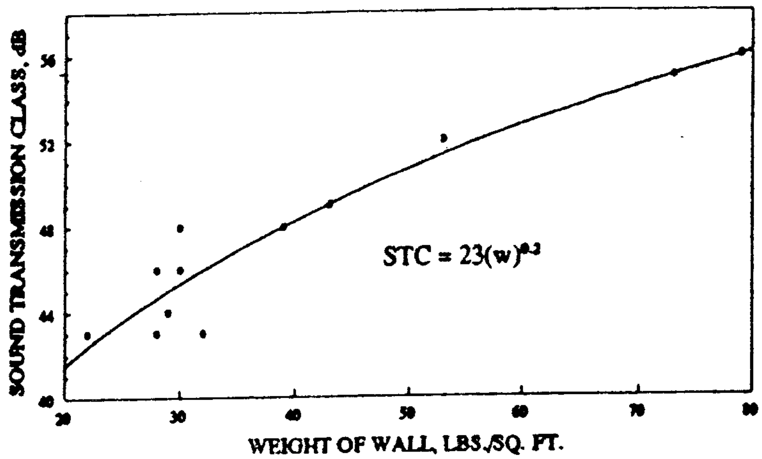


Figure 2 Wall Weight vs. STC

8.0 - Calculated STC Ratings

8.1 The calculated sound transmission class rating of a concrete masonry wall system shall be determined in accordance with Equation 1.

$$STC = 23(w)^{0.2} \qquad \text{Eqn. 1}$$

8.2 For a given STC, the required weight of the wall system shall be determined in accordance with Equation 2.

$$w_{req} = (STC / 23)^{5} \qquad \text{Eqn. 2}$$

12 Inch—2 Core Concrete Block				
Density of Concrete used in block, lbs. per cu. ft.	80	100	120	140
Type of Wall	U-Value			
1.	.27	.31	.33	.44
2.	.12	.14	.16	.19
3.	.11	.12	.13	.15
4.	.09	.09	.10	.11
5.	.06	.06	.07	.07

12 Inch Cavity Wall 4 inch dense outer wythe, ¾ inch air space, 8 inch 2 Core Concrete Block				
Density of Concrete used in block, lbs. per cu. ft.	80	100	120	140
Type of Wall	U-Value			
1.	.21	.23	.24	.27
2.	.11	.13	.15	.18
3.	.10	.11	.12	.14
4.	.08	.09	.10	.11
5.	.06	.06	.07	.07

Dry Weight in pounds of KORFIL Insulated Concrete Masonry Units

TYPE OF BLOCK		DENSITY OF CONCRETE (P.C.F.)					
		85	95	105	115	125	135
6x8x16	2 core	19	21	23	25.5	28	30
8x8x16	2 core	23.5	26.5	29	32	35	37.5
10x8x16	2 core	29	32	35.5	39	42.5	45.5
12x8x16	2 core	33.5	37.5	41.5	45	49	53

Wall Weight in pounds per sq. ft. of KORFIL Insulated Masonry Walls

DENSITY OF CONCRETE IN BLOCK (P.C.F.)		80	100	120	140
TYPE OF BLOCK					
6x8x16	2 core	26	33	40	46
8x8x16	2 core	32	40	47	55
10x8x16	2 core	38	47	57	67
12x8x16	2 core	45	55	67	78
12 inch Cavity Wall		70	78	85	93

8. MAINTENANCE

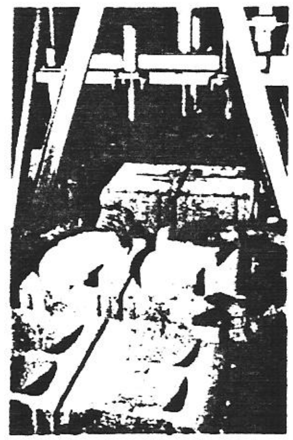
Not required.

9. TECHNICAL SERVICES

Detailed test results and comprehensive technical literature are available from KORFIL Incorporated, phone: (800) 458-4510 (in MA), (800) 628-8476 (in USA), FAX (508) 867-5702.

10. FILING SYSTEMS

Electronic SPEC-DATA®
SPEC-DATA® II
Sweet's Catalog System, Section 07200/KOR.
Brochure available upon request from KORFIL Incorporated.



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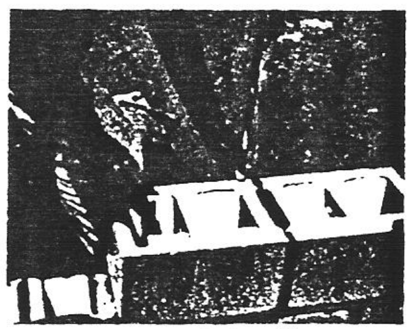

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