Casey

SOUND REDUCTION PROPERTIES OF CONCRETE MASONRY WALLS

Published by the
National Concrete Masonry Association
38 South Dearborn Street
Chicago 3, Illinois

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ACKNOWLEDGEMENT

The laboratory research forming the basis of this report was performed at the Riverbank Acoustical Laboratory of the Armour Research Foundation of Illinois Institute of Technology. The entire research program consisted of two separate series of sound transmission tests and one series of sound absorption tests.

The first portion of the research program was conducted under the supervision of Luther G. Ramer, at that time Supervisor at the Laboratory. The balance of the program was under the supervision of Ralph Huntley, Supervisor and Roy L. Richards, Assistant Physicist of the Riverbank Acoustical Laboratory.

This publication was prepared by Henry Toennies, Assistant Engineer, National Concrete Masonry Association, from the original reports submitted by the Riverbank Acoustical Laboratory.

The function of the National Concrete Masonry Association, a non-profit promotional, educational and technical organization, is to improve and extend the uses of concrete masonry through scientific research and develop new or improved products and methods. The NCMA is comprised of leading manufacturers of quality masonry units in the United States, Canada, Hawaii, Alaska, Puerto Rico, Japan, Venezuela and New Zealand. A complete list of members will be sent on request.

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I. INTRODUCTION

This report contains results from sound transmission loss tests on various types of concrete masonry wall panels, and a limited number of results from sound absorption tests. Data obtained from a series of 43 individual sound transmission loss tests and six sound absorption tests conducted by the Armour Research Foundation of the Illinois Institute of Technology at their Riverbank Acoustical Laboratory for the National Concrete Masonry Association, are reported along with other available data on sound transmission loss. Wall panels tested for sound transmission loss were of single wythe construction, of varying thicknesses, using both hollow and solid type block, unpainted and painted on both surfaces, and of three aggregate type block. Also tested for sound transmission loss were cavity walls of two different aggregate type block with two cavity spacings, and in one test with mortar pargeting applied on the cavity side of the wythe facing the sound source. The sound absorption tests were made on four inch hollow block, both painted and unpainted, from the same shipments of block used in the sound transmission tests.

The unit used to measure relative degrees of sound intensity, which corresponds approximately to loudness as perceived by the human ear, is the decibel. The decibel is an American unit which is defined as one-tenth of a "bel" named after Alexander Graham Bell. A bel is defined as the difference in sound levels of two sounds when the intensity of one is ten times the intensity of the other. It so happens that a change of one decibel in sound level gives about the smallest change in the sensation of hearing (loudness) that the ear can detect.

Noise reduction is achieved in one of two ways depending on where the source of the sound is with reference to the listener. If the listener is in the same room as the source, reduction is achieved by sound absorbing material in the same room. If the listener is in the room next to the source, reduction is achieved by a wall with a high transmission loss or sound insulating property. A material which has a high sound absorption coefficient usually has a low transmission loss.

Sound absorption is of importance in the design of large auditoriums where sounds emitted from one location are made audible at a considerable distance due to proper sound reflection. Many opera houses and theatres are designed so well acoustically that a whisper from the stage can be heard in the very last row of seats. When it is desired to minimize sound reflection, sound-absorptive materials are used for floors, walls and ceiling. Hard, impervious materials in general reflect sound very efficiently, whereas, rough, porous materials such as rugs, draperies, fiber boards and porous concrete block do not reflect well but absorb sound very well. This is because the sound waves enter the pores of the absorbing material and their energy is converted into heat by friction. It should be noted that changing the surface of the absorbing material, such as the painting of a block wall, will usually lower the absorption value of the material.

The sound absorption coefficient of a substance is defined as the ratio of the sound energy that it absorbs to the total sound energy that falls upon it. An open window absorbs all the sound that falls upon it, for all the sound goes out and none comes back. Hence, the absorption coefficient of an open window is 1. The absorption coefficient of any substance equals the ratio of the amount of sound energy it absorbs to the amount absorbed by an open window of the same size. In the English system of measure, this sound absorption coefficient is calculated as the ratio of sound absorbed per square foot by a substance to the sound absorption of one square foot of an open window. Since the absorption coefficient is a ratio it has no unit of measure, but sometimes the term "Sabin" is used when considering the sound absorbed per square foot. This term has been suggested in honor of Professor W. C. Sabine of Harvard University, a pioneer in the science of architectural acoustics.

The reduction of sound or loudness by transmission loss is of importance in the design of all buildings containing rooms where sounds from one room might prove objectionable to occupants of others. An important function of partition walls in schools, office buildings, apartments and other buildings of various occupancy types is to prevent sounds on one side of the partition from being heard on the other side. The effectiveness of different partition constructions in this regard is determined experimentally and is expressed as the sound transmission loss in decibels. The sound transmission loss is defined as the ratio in decibels of the incident sound energy on the loud side of the wall to the transmitted sound energy on the quiet side of the wall.

The average sound transmission loss of partitions of ordinary wood and plaster or masonry construction ranges from about 25 to 55 or 60 decibels. A reduction factor of over 50 decibels is usually considered more than adequate even when fairly high noise levels are to be resisted.

Architects, including those versed in acoustics, do not always agree on the sound transmission loss necessary to achieve the desired degree of quiet or sound isolation in a specific case. In general, acceptable factors are 40 decibels for partitions between offices and school classrooms, 45 decibels for school corridor walls and party walls in apartment buildings, and 50 decibels for partitions separating music rooms, auditoriums and the like from other rooms or exterior noises.

II. SOUND TRANSMISSION LOSS TESTS

A. Description of Materials, Test Walls and Test Methods

All sound transmission loss test panels were constructed in place and transmission loss tests made by the Riverbank Laboratory for the National Concrete Masonry Association, and supplementary tests on the physical properties of test units were performed at two outside commercial testing laboratories under separate contractual agreements. All block used in the test panels were of regular commercial quality and were obtained from Association member plants.

1. Test Units

The concrete masonry units used in the sound transmission loss panels were tested by commercial testing laboratories for compressive strength, gross and net volumes, dry weight, moisture content, concrete unit weight and absorption after 30 minutes, 2, 8, and 24 hours of immersion. The physical properties of the test block are correlated with the various sound transmission test numbers in Table 1. The measuring of the absorption values after various time periods of immersion was an attempt to correlate the rate of water penetration into block with the sound transmission loss. However, the test units absorbed water so rapidly (over 90 percent of total absorption in 30 minutes) that no correlation was possible.

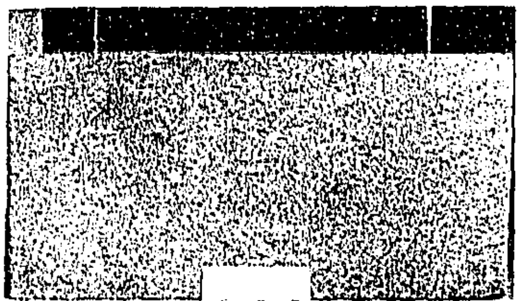


Fig. 1. Cinder Aggregate Concrete Block

All test block were made of aggregate graded from 3/8 in. to 0 and were of a uniform medium texture, as shown in Figs. 1, 2, 3. Twenty-eight day compressive strengths of at least 700 psi for hollow units and 1200 psi (ASTM Grade B, load-bearing) for the solid units were specified and actual strengths obtained were well above minimum.

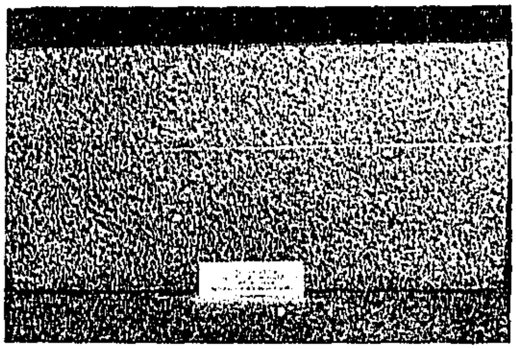


Fig. 2. Expanded Shale Aggregate Concrete Block

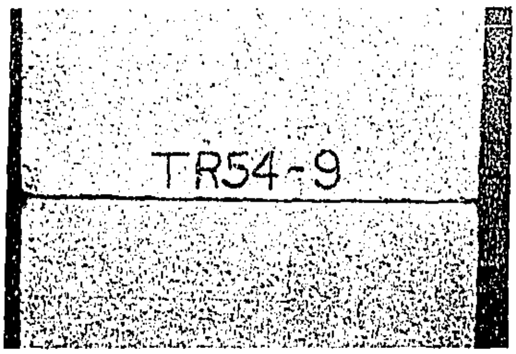


Fig. 3. Dense Aggregate Concrete Block

2. Wall Panels

All test block were stored under cover in air for a minimum of 14 days at the laboratory before erection of the test walls. Walls were erected in the same opening in the wall of the Riverbank Laboratory reverberation chamber. This opening is 6'2" wide by 7'5" high, see Fig. 4, and is the front face of a smaller sound receiving room, the back wall of which is treated with highly sound absorbent glass fiber wedges.

TABLE I

PHYSICAL PROPERTIES OF CONCRETE BLOCK USED IN SOUND TRANSMISSION STUDIES

Aggregate Type	Test No.	Block Type	Block Dry Wt., Lb.	Compressive Strength, Psi		Percent Core Volume	Concrete Unit Wt., Lb. Per Cu. Ft.	Absorption, Lb. Per Cu. Ft. After Immersion Period			
				Gross Area	Net Area			30 Min.	2 Hr.	8 Hr.	24 Hr.
Cinder	TR 51-57	4" Hollow	16.1	1427	1990	28.3	90.1	12.2	12.7	13.0	13.5
"	TR 51-57a	"	"	"	"	"	"	"	"	"	"
"	TR 52-1	"	"	"	"	"	"	"	"	"	"
"	TR 51-60	"	"	"	"	"	"	"	"	"	"
"	TR 54-11	"	14.8	1000	1425	29.2	84.1	12.9	13.4	13.9	14.7
"	TR 54-12	"	"	"	"	"	"	"	"	"	"
"	TR 54-16*	"	"	"	"	"	"	"	"	"	"
"	TR 54-17*	"	"	"	"	"	"	"	"	"	"
"	TR 52-26	4" Solid	20.4	1831	1831	0.0	83.3	12.5	13.2	13.7	14.2
"	TR 52-29	6" Hollow	21.3	1084	1690	35.8	85.0	12.9	13.2	13.8	14.4
"	TR 52-27	6" Solid	32.6	1741	1741	0.0	85.5	13.8	14.4	14.6	14.9
"	TR 52-27a	"	"	"	"	"	"	"	"	"	"
"	TR 52-28	"	"	"	"	"	"	"	"	"	"
"	TR 52-45	"	"	"	"	"	"	"	"	"	"
"	TR 54-13	8" Hollow	24.8	758	1361	44.3	84.3	11.6	12.0	12.6	14.2
"	TR 54-14	"	"	"	"	"	"	"	"	"	"
"	TR 54-15	"	"	"	"	"	"	"	"	"	"
Expanded Shale	TR 51-62	4" Hollow	16.3	1334	1848	27.8	88.9	12.7	13.0	13.7	14.6
"	TR 51-62a	"	"	"	"	"	"	"	"	"	"
"	TR 51-58	"	"	"	"	"	"	"	"	"	"
"	TR 51-59	"	"	"	"	"	"	"	"	"	"
"	TR 52-13	"	"	"	"	"	"	"	"	"	"
"	TR 52-14	"	"	"	"	"	"	"	"	"	"
"	TR 52-30	"	15.7	1931	2540	24.9	85.2	10.8	10.8	10.8	11.4
"	TR 54-18	"	15.4	1652	2275	27.4	84.8	10.3	10.7	11.4	11.9
"	TR 54-19	4" Solid	20.2	1933	1933	0.0	83.5	9.2	9.7	10.2	10.6
"	TR 52-34	"	20.5	2588	2588	0.0	86.3	8.5	8.9	9.3	9.7
"	TR 52-24	6" Hollow	19.4	1541	2720	43.3	87.8	10.2	10.6	11.3	11.9
"	TR 52-33	"	19.5	1710	2975	42.5	88.5	9.6	10.0	10.5	10.9
"	TR 52-35	6" Solid	30.1	2282	2282	0.0	84.8	7.9	8.2	8.7	8.9
"	TR 52-35a	"	"	"	"	"	"	"	"	"	"
"	TR 52-37	"	"	"	"	"	"	"	"	"	"
"	TR 52-38	"	"	"	"	"	"	"	"	"	"
"	TR 52-40	"	"	"	"	"	"	"	"	"	"
"	TR 52-41	"	"	"	"	"	"	"	"	"	"
Dense	TR 54-3	4" Hollow	24.8	1633	2210	26.0	131.9	9.3	9.8	10.4	10.7
"	TR 54-4	"	"	"	"	"	"	"	"	"	"
"	TR 54-16*	"	"	"	"	"	"	"	"	"	"
"	TR 54-17*	"	"	"	"	"	"	"	"	"	"
"	TR 54-5	4" Solid	32.0	2291	2291	0.0	131.3	7.9	8.4	8.9	9.7
"	TR 54-6	"	"	"	"	"	"	"	"	"	"
"	TR 54-7	6" Hollow	30.6	1481	2570	42.3	136.7	7.6	8.0	9.0	9.6
"	TR 54-8	"	"	"	"	"	"	"	"	"	"
"	TR 54-9	8" Hollow	42.9	1322	2280	41.2	136.2	8.3	9.1	9.3	9.8
"	TR 54-10	"	"	"	"	"	"	"	"	"	"

* Cavity Walls -- One Cinder Aggregate Wythe and One Dense Aggregate Wythe

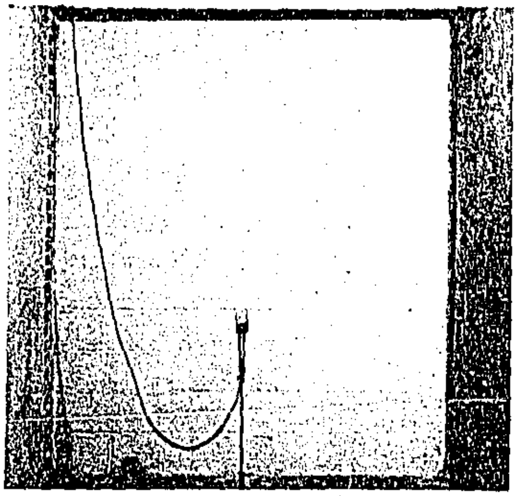


Fig. 4. Concrete Masonry Wall Panel for Sound Transmission Loss Test

Mortar joints of the test walls were made 3/8 in. thick and tooled concave. Face shell mortar bedding was used in laying hollow units and full mortar bedding for all solid units.

3. Painted Walls

Two types of paint were included to determine the effect of paint coatings on the sound transmission losses. The number of coats applied to each side of the wall panel, type of paint, coverage per gallon, and the covering index of the paint are given in Table 2. Paint CB is a portland cement base paint mixed in the proportions of 10 pounds of paint powder to one gallon of water.

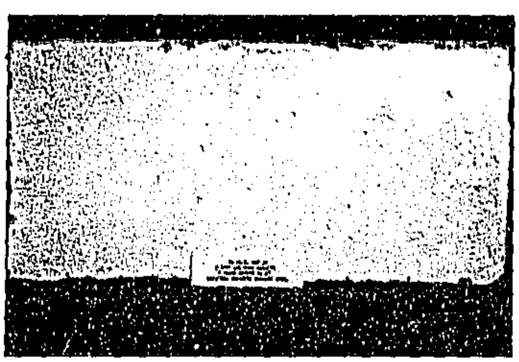


Fig. 5. Two Coats of Cement Base Paint on Expanded Shale Block

Cement base paint, Fig. 5, was "scrubbed on" with a fiber bristle scrub brush, after the receiving surface had been slightly dampened, and was cured by fog spraying twice a day for two days beginning 12 hours after application of paint.

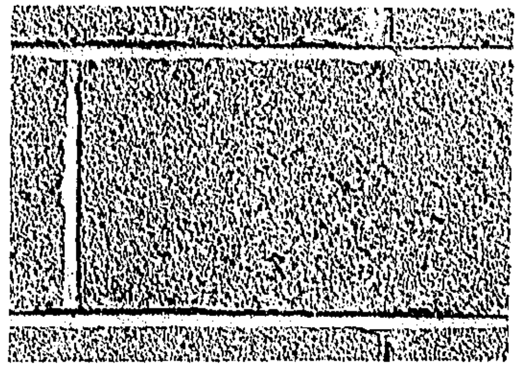


Fig. 6. One Coat of Resin Emulsion Paint on Expanded Shale Block

Paint RE is a casein-alkyd resin emulsion paint designed for interior use and applied according to manufacturers' directions. This paint, Fig. 6, was applied with a 3 in. long horsehair bristle brush.

4. Test Facilities

The sound for these measurements was generated by loudspeakers placed in the reverberation chamber. An oscillator and power amplifier provided the loudspeakers with a signal. The level, or intensity, of the sound in the receiving room was held constant at about 45 decibels re 0.0002 microbar. This was accomplished by changing the level in the reverberation chamber according to the change of the sound transmission loss of the test wall with frequency. The frequency of the sound was swept from 100 to 4000 cycles per second over a period of 7-1/4 minutes, and was warbled plus and minus 20 cycles from the base frequency five times per second.

Pressure-gradient type microphones were placed on both sides of the test wall, one in the reverberation chamber, or loud side, and one in the receiving room, or quiet side. A mechanical linkage between the oscillator and a twin-channel graphic level recorder made it possible to obtain a simultaneous recording of the output of each microphone while the frequency of the sound was slowly ad-

TABLE 2

SUMMARY OF SOUND TRANSMISSION TEST RESULTS

WALL PHYSICAL PROPERTIES							SOUND TRANSMISSION LOSS, Decibels At Various Frequencies (CPS)									
Test No.	Aggregate Type	Block Type	Wall Wt., Lb. Per Sq. Ft.	Surface Treatment: No. Coats-Type	Surface Treatment: Coverage, Sq. Ft. Per Gal.	Surface Treatment: Coverage Index	125	175	250	350	500	700	1000	2000	4000	Ave. Loss
TR 51-57	Cinder	4" Hollow	19.2	None	---	---	26.5	28.0	31.0	34.0	37.5	42.0	44.0	47.0	48.0	37.6
TR 51-57a	"	"	19.2	None	---	---	24.5	28.5	30.5	33.0	36.5	41.0	45.0	47.5	49.0	37.3
TR 52-1	"	"	19.4	1-RE	139	1-2	30.0	32.0	34.0	35.0	40.5	45.5	50.0	55.0	52.5	41.6
TR 51-60	"	"	19.4	1-CB	136	2-3	36.5	38.5	42.5	45.0	46.0	48.5	54.0	56.0	54.0	46.8
TR 52-26	"	4" Solid	24.4	None	---	---	22.0	25.0	29.0	31.0	31.0	32.0	34.0	40.0	41.0	31.7
TR 52-29	"	6" Hollow	25.4	None	---	---	27.5	32.5	36.0	40.5	45.0	47.0	51.0	52.5	47.0	42.1
TR 52-27	"	6" Solid	40.2	None	---	---	17.0	22.0	24.0	35.0	40.0	45.5	51.5	58.5	62.5	39.6
TR 52-27a	"	"	40.2	None	---	---	22.5	27.5	32.0	35.0	37.5	40.5	44.0	49.0	48.5	37.4
TR 52-28	"	"	40.4	1-RE	143	3-4	34.5	39.0	44.0	47.5	50.5	52.0	55.0	60.5	57.0	48.9
TR 52-45	"	"	40.4	1-CB	141	2-3	29.0	34.0	39.0	43.0	46.0	47.5	53.0	55.0	52.5	43.3
TR 54-13	"	8" Hollow	28.8	None	---	---	18.5	22.0	28.0	34.0	37.5	39.0	39.5	41.5	40.0	33.3
TR 54-14	"	"	29.2	1-CB	57	4-5	31.0	35.5	40.0	43.5	46.0	48.0	50.5	50.5	41.5	42.9
*TR 54-15	"	"	28.8	None	---	---	21.5	27.0	33.0	36.0	38.0	38.5	39.5	45.0	47.0	36.2
TR 51-62	Expanded Shale	4" Hollow	19.0	None	---	---	23.5	27.5	29.5	30.0	33.0	39.0	42.0	44.0	43.5	34.7
TR 51-62a	"	"	19.0	None	---	---	20.5	24.0	28.5	31.0	34.5	39.0	41.0	44.0	43.5	34.0
TR 52-30	"	"	18.3	None	---	---	19.5	23.0	27.5	29.0	34.0	39.0	41.5	44.0	47.0	33.8
TR 54-18	"	"	18.5	None	---	---	19.5	22.5	26.5	27.0	30.0	35.0	39.5	41.5	43.0	31.6
TR 51-58	"	"	19.2	1-RE	139	1-2	25.0	28.0	32.0	33.0	38.0	41.0	43.0	46.0	44.0	36.7
TR 51-59	"	"	19.3	2-RE	139[a]&370[b]	2-3	24.0	29.5	32.0	34.0	38.0	42.0	43.5	46.0	43.5	36.9
TR 52-13	"	"	19.2	1-CB	138	3-4	22.5	28.0	34.5	38.0	41.5	43.0	44.0	49.0	42.5	38.1
TR 52-14	"	"	19.4	2-CB	138[a]&221[b]	5	34.0	36.5	40.0	40.0	45.0	47.0	49.5	51.0	46.0	43.2
TR 52-34	"	4" Solid	24.5	None	---	---	21.0	24.5	28.0	28.0	28.5	30.5	32.5	37.5	41.0	30.2
TR 54-19	"	"	23.5	None	---	---	17.5	21.0	24.5	25.0	25.0	26.0	28.5	33.0	32.0	25.8
TR 52-24	"	6" Hollow	23.4	None	---	---	29.5	32.0	36.5	41.0	44.5	44.0	43.0	43.0	36.5	38.9
TR 52-33	"	"	22.8	None	---	---	22.0	25.5	30.0	34.5	39.0	42.0	45.5	46.0	42.0	36.3
TR 52-35	"	6" Solid	36.7	None	---	---	19.0	23.0	26.0	27.5	29.0	31.0	33.0	38.0	39.5	29.6
TR 52-35a	"	"	36.7	None	---	---	15.5	19.5	23.0	22.5	25.0	26.0	28.0	32.5	34.0	25.1
TR 52-37	"	"	36.9	1-RE	142	2-3	21.0	24.0	26.5	27.5	29.0	31.5	35.0	39.0	41.5	30.6
TR 52-38	"	"	37.0	2-RE	142[a]&259[b]	3-4	20.0	23.0	27.0	29.0	30.0	33.0	36.5	42.0	43.5	31.6
TR 52-40	"	"	36.9	1-CB	141	2-3	21.0	23.5	28.0	30.5	32.5	35.0	39.0	44.5	41.0	32.8
TR 52-41	"	"	37.1	2-CB	141[a]&134[b]	3-4	25.0	27.5	31.5	35.5	38.0	40.0	44.0	48.0	42.5	36.9
TR 54-3	Dense	4" Hollow	24.5	None	---	---	31.0	35.5	39.0	41.5	43.0	43.5	47.0	54.0	50.0	42.7
TR 54-4	"	"	24.7	1-CB	95	4-5	36.0	39.5	41.5	42.5	45.0	45.5	48.0	54.0	49.0	44.6

* Core spaces filled with vermiculite insulating fill.

TABLE 2--Continued

SUMMARY OF SOUND TRANSMISSION TEST RESULTS

WALL PHYSICAL PROPERTIES							SOUND TRANSMISSION LOSS, Decibels At Various Frequencies (CPS)									
				Surface Treatment												
Test No.	Aggregate Type	Block Type	Wall Wt., Lb. Per Sq. Ft.	No. Coats-Type	Coverage, Sq. Ft. Per Gal.	Coverage Index	125	175	250	350	500	700	1000	2000	4000	Ave. Loss
TR 54-5	Dense	4" Solid	36.8	None	---	---	..5.0	28.0	31.0	32.5	34.0	36.0	41.0	46.5	46.0	35.6
TR 54-6	"	"	37.5	2-CB	57a&95b	5	41.0	46.0	47.0	46.5	48.5	51.5	54.0	55.0	50.0	48.9
TR 54-7	"	6" Hollow	34.9	None	---	---	31.0	44.5	50.0	50.5	51.0	53.0	56.0	56.0	47.0	49.4
TR 54-8	"	"	35.1	1-RE	115	4-5	37.5	47.0	54.0	51.5	52.0	54.5	57.0	56.0	46.5	50.7
TR 54-9	"	8" Hollow	49.2	None	---	---	39.5	46.0	52.0	54.0	53.5	55.0	57.5	58.5	50.0	51.8
TR 54-10	"	"	49.6	2-RE	115a&229b	5	38.0	48.5	54.0	54.0	54.5	58.0	60.0	58.5	49.0	52.7

CAVITY WALLS

WALL PHYSICAL PROPERTIES						SOUND TRANSMISSION LOSS, Decibels At Various Frequencies (CPS)									
Test No.	Aggregate Type	Block Type	Wall Position	Wall Wt., Lb. Per Sq. Ft.	Cavity Space	125	175	250	350	500	700	1000	2000	4000	Ave. Loss
TR 54-11	Cinder Cinder	4" Hollow "	Source Side Quiet Side	37.7	3/8"	21.5	26.0	32.0	37.5	42.5	46.5	51.5	63.5	59.0	42.2
TR 54-12	Cinder Cinder	4" Hollow "	Source Side* Quiet Side	41.0	3/8"	35.0	41.5	45.5	48.0	50.0	53.5	58.0	67.0	64.0	51.4
TR 54-16	Cinder Dense	4" Hollow "	Source Side Quiet Side	43.3	3/8"	37.0	42.0	47.0	51.0	54.0	56.0	58.5	67.5	68.0	53.4
TR 54-17	Cinder Dense	4" Hollow "	Source Side Quiet Side	43.3	2-3/8"	39.0	43.5	48.0	52.0	55.0	56.5	57.5	66.5	66.0	53.8

a - First coat coverage. b - Second coat coverage. * 1/4" Back Plaster (plaster same mix as mortar).
Symbols: RE = Resin Emulsion Paint CB = Cement Base Paint

Index = Relative degree of paint coverage
1 = Very poor coverage
2, 3, 4 = Intermediate degrees of coverage
5 = Complete coverage

vanced through the band. This automatically recorded data was used in the preparation of the sound transmission loss curves in this report.

B. Test Results

Results of all 43 sound transmission loss tests are presented as Table 2. Individual test numbers are given and correspond to the test numbers of Table 1 giving the test block physical properties, so that individual block properties may be compared to sound transmission losses if desired.

In Table 2 the wall weight in pounds per square foot has been calculated from the weight data reported by the commercial testing laboratory. Since the commercial testing laboratory made these measurements on block from the same source but on units other than those actually used in the test panels, and since the weight of the mortar has been neglected in wall weight calculations, the values presented are approximate.

When a paint surface treatment was used, the type of paint, the number of coats applied to each side, the coverage in square feet per gallon of mixed paint, and the relative coverage index are given. The paint is in each case either a cement base paint, designated CB, or a casein-alkyd resin emulsion, designated RE, applied in the manner described previously. Coverage index numbers range from one to five and indicate the relative degree to which the surface was coated and sealed. No. 1 is indicative of very poor coverage, No. 5 designates complete coverage (complete seal of surface and pores as visually judged) and the intermediate numbers represent the various degrees of coverage between those extremes.

Sound transmission loss factors are given in Table 2 for each of nine separate test frequencies. An average of these nine individual factors is given in each case as the average sound transmission loss. This manner of presentation meets the requirement "Tentative Recommended Practice for Laboratory Measurement of Airborne-Sound Transmission Loss of Building Floors and Walls," (ASTM Designation: E90-50T). Generally the average transmission loss is considered sufficient for a comparison of wall types. Where instances arise involving objectionable sounds of a particular frequency, the data in Table 2 or the transmission loss curves shown in the Appendix for each frequency will permit comparisons.

C. Discussion of Test Results

1. Effect of Wall Weight

Results of this test series indicate that the sound transmission loss which may be expected when sound travels through a concrete masonry wall is not necessarily a function of the weight of the wall per square foot of wall area. This relationship is shown in Fig. 7 where the average transmission losses for the various unpainted walls are plotted against the corresponding weight per square foot.

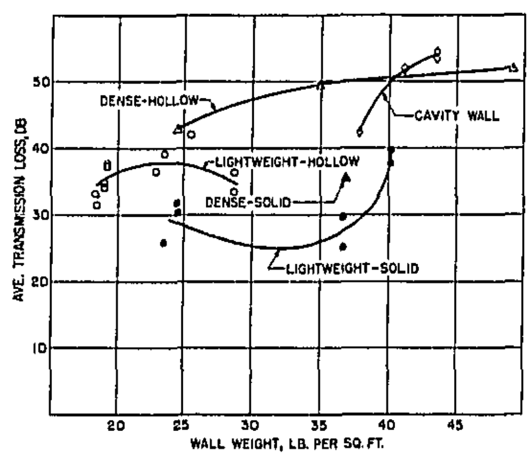


Fig. 7. Effect of Wall Weight on Sound Transmission Loss

It will be noted that for a specific aggregate type and block design, sound transmission loss usually increases slightly with wall weight but the relation is not always consistent apparently because of other factors.

2. Effect of Aggregate Type

In general, the sound transmission loss was greater for dense aggregate block walls than for lightweight block of similar design and thickness. Comparisons are shown in Figs. 8 through 13.

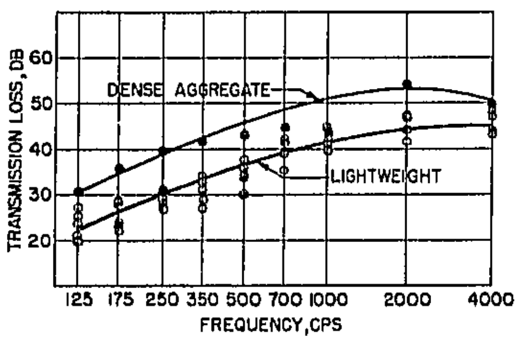


Fig. 8. Sound Transmission Loss Curves for Unpainted 4 in. Hollow Block

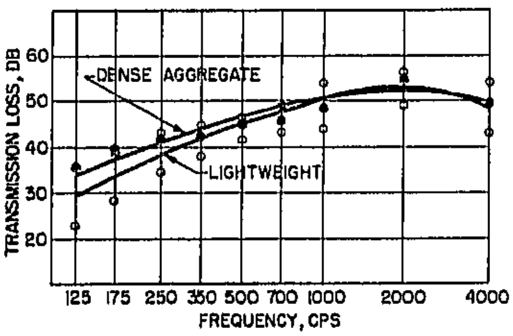


Fig. 9. Sound Transmission Loss Curves for Painted 4 in. Hollow Block

For the 4 in. hollow block panels, without surface treatment, Fig. 8, the dense aggregate seems to offer up to ten decibels greater sound control, depending upon the sound frequency. The lower values obtained for the dense aggregate panel at 500, 700, and 1000 cycles per second indicate a slightly lessened advantage in this frequency range. The application of one coat of cement base paint to these 4 in. hollow block panels, Fig. 9, seems to virtually eliminate the advantage offered by dense aggregate for transmitted sound control.

The 8 in. hollow unpainted block are compared in Fig. 10. The advantage of dense aggregate appears to be as much as 20 decibels in the low frequencies and, as in the case of 4 in. block, the difference tends to reduce in the higher frequency range. Application of paint to these 8 in. walls, Fig. 11, appears to reduce the difference in the sound transmission properties due to aggregate.

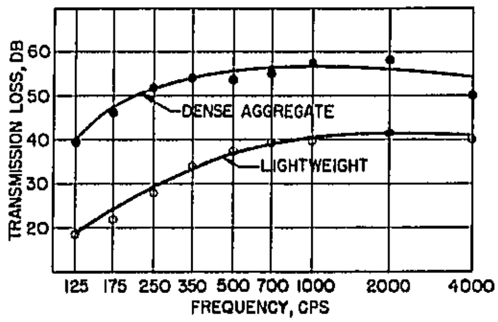


Fig. 10. Sound Transmission Loss Curves for Unpainted 8 in. Hollow Block

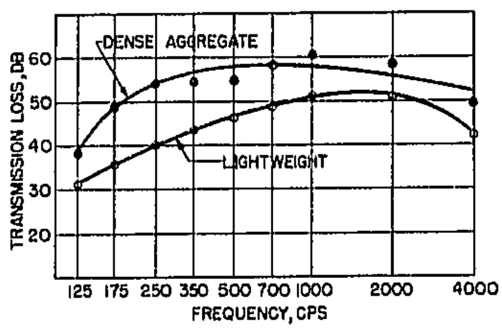


Fig. 11. Sound Transmission Loss Curves for Painted 8 in. Hollow Block

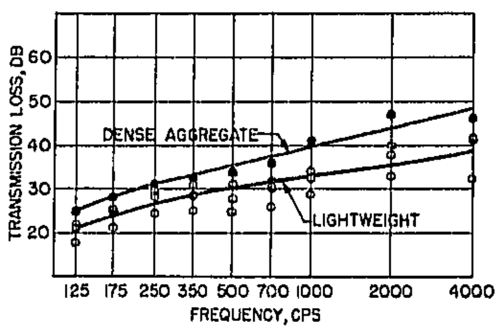


Fig. 12. Sound Transmission Loss Curves for Unpainted 4 in. Solid Block

TABLE 3

EFFECTIVENESS OF PAINTING CONCRETE MASONRY SURFACES TO INCREASE SOUND TRANSMISSION REDUCTION

Wall Type	*Average Loss In Decibels For Unpainted Wall, Db.	Increase In Transmission Loss (Db.) Due To Various Paint Coverings, Number Of Coats, Type Paint.			
		1-RE	1-CB	2-RE	2-CB
4" Hollow-Cinder	37.5	4.1	9.3		
6" Solid-Cinder	38.5	10.4	4.8		
8" Hollow-Cinder	33.3		9.6		
4" Hollow-Exp. Shale	33.5	3.2	4.6	3.4	9.7
6" Solid-Exp. Shale	27.4	3.2	5.4	4.2	9.5
4" Hollow-Dense	42.7		1.9		
4" Solid-Dense	35.6				13.3
6" Hollow-Dense	49.4	1.3			
8" Hollow-Dense	51.8			0.9	

* An average value, based on all applicable tests where more than one was run.

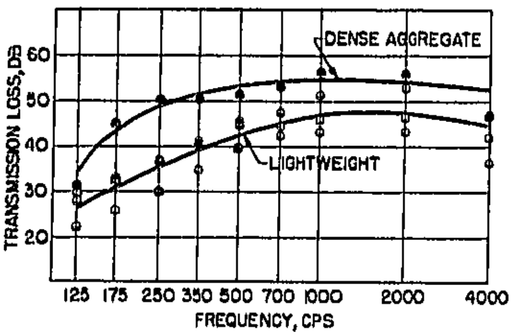


Fig. 13. Sound Transmission Loss Curves for Unpainted 6 in. Hollow Block

The greater sound transmission loss with dense aggregate over lightweight is again shown in Figs. 12 and 13 for unpainted 4 in. solid units and unpainted 6 in. hollow block walls.

These results indicate that the greater sound transmission through the lightweight unit panels over that of the dense may be due in part to differences in the respective concrete porosities rather than to differences in the densities of the aggregate materials. Note that the application of a paint to these panel surfaces, which effectively seals off this porosity, reduces the transmitted sound considerably without materially changing the wall weight. This suggests that the producer of lightweight block may improve their sound transmission properties by careful selection of favorably graded aggregate and production of more dense masonry units.

3. Effect of Painting Wall Surfaces

In all cases the application of paint to the wall surfaces increased the sound transmission loss. The amount of increase appears to vary, depending on the type of block, the texture of the block surface, the type and amount of paint used, and the extent of paint coverage. Generally the cement base paint increased the sound transmission loss more than the resin emulsion. In Table 3 the increase in decibels of sound transmission loss is given for the various wall types due to painting.

From Table 3, it may be noted that one coat of cement base paint generally offers greater increase in transmitted sound control than two coats of resin emulsion. A maximum increase, due to painting, seems to occur when two coats of cement base paint are applied to the masonry wall surfaces. All of the painted test panels in this series of sound transmission loss tests were painted on both sides.

4. Effect of Cavity Wall Construction

Concrete masonry cavity wall construction appears to be very effective in reducing transmitted sound even though the walls are not painted. For example, the sound transmission loss which was obtained from the unpainted, lightweight cavity wall, Test TR 54-11, Table 2, indicates good sound control may be obtained regardless of type of exterior surface treatment selected. This type of construction may be used for the reduction of transmitted sound without altering the open surface texture of the concrete block which is effective in sound absorption.

Sound transmission loss properties of cavity walls may be further increased by back plastering as was done in Test TR 54-12, Table 2. This treatment increases the sound transmission loss of the lightweight cavity wall without too great an increase in weight. Again the rough open texture of the block surface is left unaltered, if desired, for sound control by absorption.

The use of dense aggregate block for one wythe with lightweight block for the other wythe was simulated in the cavity wall panels TR 54-16 and TR 54-17. A substantial increase in the sound transmission loss occurred in this construction over that obtained through the lightweight cavity wall, due to the heavier dense aggregate and less porous concrete. Increasing the cavity space from 3/8 in. to 2-3/8 in. had very little effect on the sound transmission loss of cavity walls in these tests.

5. Effect of Masonry Unit Design

The design of the block unit appears to have a significant effect on the sound transmission loss of a wall. As may be noted in Fig. 7, the sound loss through solid block is somewhat lower per pound of wall area than

TABLE 4

CORRELATION OF SOUND TRANSMISSION LOSS WITH EFFECTIVE THICKNESS OF UNPAINTED CONCRETE MASONRY UNITS

Aggregate Type	Nominal Thickness, Inches	Effective Thickness, Inches	Average Transmission Loss, Db.	Transmission Loss Per Effective Inch Thickness, Db. Per In.
Hollow Units				
Cinder	4	2.62	37.6	14.35
Cinder	4	2.62	37.6	14.20
Cinder	4	3.62	42.1	11.63
Cinder	8	4.25	33.3	7.84
Exp. Shale	4	2.62	34.7	13.24
Exp. Shale	4	2.62	34.0	12.97
Exp. Shale	4	2.71	33.8	12.47
Exp. Shale	4	2.64	31.6	11.96
Exp. Shale	6	3.20	38.9	12.15
Exp. Shale	6	3.23	36.3	11.23
Dense	4	2.68	42.7	15.93
Dense	6	3.24	49.4	15.23
Dense	8	4.59	51.8	11.29
Average				12.44
Solid Units				
Cinder	4	3.63	31.7	8.73
Cinder	6	5.63	39.6	7.04
Cinder	6	5.63	37.4	6.65
Exp. Shale	4	3.59	30.2	8.41
Exp. Shale	4	3.63	25.8	7.11
Exp. Shale	6	5.61	29.6	5.28
Exp. Shale	6	5.61	25.1	4.47
Dense	4	3.63	35.6	9.81
Average				7.19

that of hollow unit walls. The exact cause of this difference is not known, but may be due to the reflection and absorption of sound waves within the core space of the hollow units.

In an effort to determine the relative efficiency of the two block designs, the sound transmission loss of the various type block per inch of effective, or net equivalent, thickness has been calculated in Table 4. The net equivalent thickness of a hollow block is the total solid content of the block expressed as inches of thickness. It is obtained by dividing the net volume of the block by the measured face area. A solid block has a net equivalent thickness equal to its actual measured thickness. Expressed in terms of sound transmission loss per inch of net equivalent thickness, the hollow units are on an average about 75% more efficient in reducing transmitted sound than the solid units.

6. Effect of Filling Cores of Hollow Unit Masonry Walls

The filling of the block core spaces with low density insulating fill has little effect on the sound transmission properties of concrete masonry. In the single test, TR 54-15, Table 2, in which this was done, the fill resulted in an increase of approximately three decibels. This procedure, although providing rather limited benefit in sound control, is often used to increase the heat insulating properties of concrete masonry.

III. AVERAGE SOUND TRANSMISSION LOSS VALUES FOR CONCRETE MASONRY WALLS

Table 5 has been prepared as an aid to the architect or designer concerned with average sound transmission loss values for various types of concrete masonry walls. The values shown are based upon data from several sources as noted. The difference between maximum and minimum values is rather wide in some instances due presumably to differences in testing procedures and facilities and to normal variations in materials.

TABLE 5

AVERAGE SOUND TRANSMISSION* LOSSES FOR VARIOUS CONCRETE MASONRY WALL CONSTRUCTIONS

Wall Description		Average Sound Transmission Losses for Various Wall Treatments, Approximate Decibel Range					
Construction	Aggregate	Un-treated	No. of Tests	Painted	No. of Tests	Plas-tered	No. of Tests
3" Hollow	Lightweight	36	1	44	1	42-45	2
4" Hollow	Dense	43	1	45	1	-	0
	Lightweight	32-38	8	38-47	7	35-50	7
4" Solid	Dense	36	1	49	1	-	0
	Lightweight	26-32	3	-	0	-	0
6" Hollow	Dense	49	1	51	1	-	0
	Lightweight	36-45	5	52	1	49	1
6" Solid	Lightweight	25-40	4	31-49	6	-	0
8" Hollow	Dense	52	1	53	1	-	0
	Lightweight	33-48	4	43	1	51-53	4
12" Hollow	Lightweight	52	1	-	0	54	1
Cavity Wall Two 3"	Lightweight	-	0	-	0	56**	1
Cavity Wall Two 4" Hollow	Lightweight	42	1	-	0	52-57**	2
Cavity Wall One 4" / One 4"	Dense / Lightweight	53-54	2				
Sub-Totals		Un-treated	33	Painted	20	Plas-tered	18

* Data are from various tests as follows:

1. National Bureau of Standards Report BMS17........................ 2 tests
2. National Bureau of Standards Supplement to Report BMS17............ 2 tests
3. Data reported in Acoustics and Architecture by Paul E. Sabine .... 2 tests
4. Tests conducted at Riverbank Laboratories ....22 tests
5. National Concrete Masonry Association tests conducted at Riverbank Laboratories.................................. 43 tests

Total 71 tests

**Cavity walls plastered on one unexposed face (cavity side).

IV. SOUND ABSORPTION TESTS

A. Description of Materials and Test Methods

The sound absorption test panels were constructed in place and sound absorption measurements were also made by the Riverbank Acoustical Laboratories for the National Concrete Masonry Association. This portion of the test program was conducted to determine the effect of heavy paint coatings on the sound absorption properties of the masonry. Sound absorption test panels were constructed of concrete block from the same source, and paint types and application were similar to those used in the sound transmission loss test.

Sound absorption measurements were first made on the unpainted test panels. Panels were then given a single coat of paint and absorption measurements retaken, followed by application of a second coat of paint and subsequent sound absorption measurements. The program was limited to one test panel of expanded shale block with resin emulsion paint, and one test panel of cinder aggregate block with cement base paint making a total of six sound absorption tests. The physical properties of the concrete masonry units are described adequately in the preceding section, Table 1. The type of paint and method of application were also similar to that described in sound transmission loss tests with the exception that paints were applied to but one surface in the sound absorption tests.

Sound absorption measurements differ from sound transmission loss measurements in that test panels are constructed in a horizontal position, rather than as walls, and the entire test is performed in a single room, Fig. 14. The test procedure consists of generating a sound pressure level of about 110 decibels by means of a loudspeaker in one corner of the room then turning off the sound source and measuring the time rate as the sound fades away. This time is called the "decay rate," and by comparing the decay rate of the room when empty with the decay rate of the room when the sound absorbent test panel is in position, the sound absorption coefficient of the material is calculated. The test is performed at a number of different sound frequencies, as in the case of sound transmission loss tests, and an average sound absorption coefficient is calculated. This average sound absorption coefficient is called the noise reduction coefficient (NRC) in Table 6.

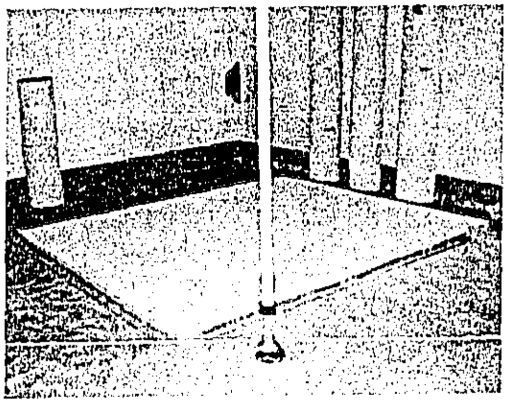


Fig. 14. Sound Absorption Test Panel Used in NCMA Sound Absorption Test

B. Test Results

TABLE 6 - SOUND ABSORPTION TEST RESULTS

WALL PROPERTIES				SOUND ABSORPTION COEFFICIENT AT VARIOUS FREQUENCIES (CPS)						
		Surface Treatment								
Test No.	Aggregate Type	No. Coats-Type	Coverage, Sq. Ft. Per Gal.	125	250	500	1000	2000	4000	NRC
A55-90	Exp. Shale	None	--	.31	.59	.41	.34	.50	.40	.45
A55-91	Exp. Shale	1-RE	99	.35	.43	.30	.25	.29	.29	.30
A55-92	Exp. Shale	2-RE	99^a & 148^b	.23	.23	.16	.16	.15	.19	.20
A55-93	Cinder	None	--	.36	.44	.31	.29	.39	.25	.35
A55-94	Cinder	1-CB	65	.14	.09	.07	.09	.10	.09	.10
A55-95	Cinder	2-CB	65^a & 159^b	.10	.05	.06	.07	.09	.08	.05

Symbols: RE = Resin Emulsion Paint CB = Cement Base Paint NRC = Noise Reduction Coefficient - Average of 250, 500, 1000, and 2000 cycle sound absorption coefficients.
a = First coat coverage b = Second coat coverage

C. Discussion of Test Results

The effect of painting the concrete masonry surfaces was a reduction in the sound absorption value of the material. Two coats of cement base paint which were very effective in reducing transmitted sound reduced the absorptive value of the cinder block to a value comparable to a plastered surface. Figs. 15 and 16 indicate the degree of surface texture change due to the application of cement base paint.

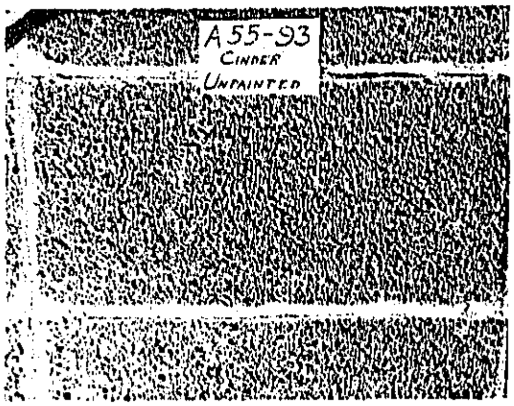


Fig. 15. Unpainted Cinder Block for Sound Absorption Test

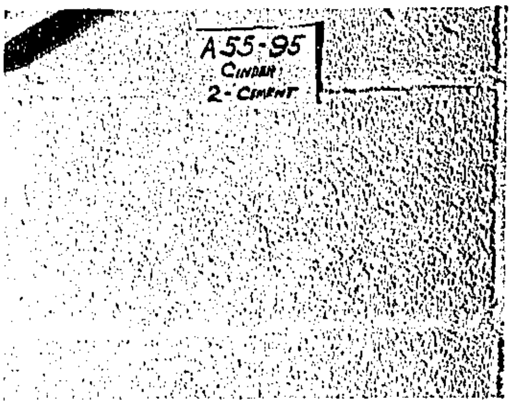


Fig. 16. Painted Cinder Block Panel for Sound Absorption Test

The resin emulsion paint had less effect on the sound absorption coefficient than the cement base paint, although the reduction was significant. The changes of surface texture due to painting with resin emulsion paint are shown in Figs. 17 and 18. It will be recalled that the resin emulsion paint was less effective than cement paint in reducing transmitted sound.

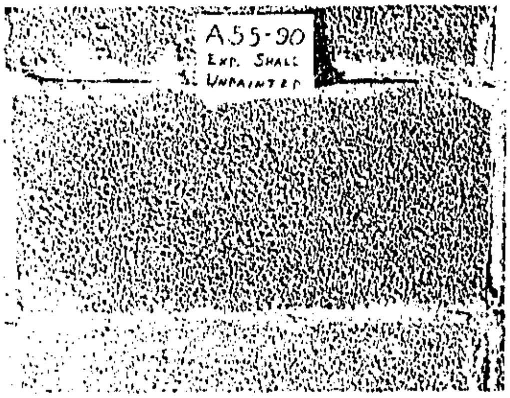


Fig. 17. Unpainted Expanded Shale Block Panel for Sound Absorption Test

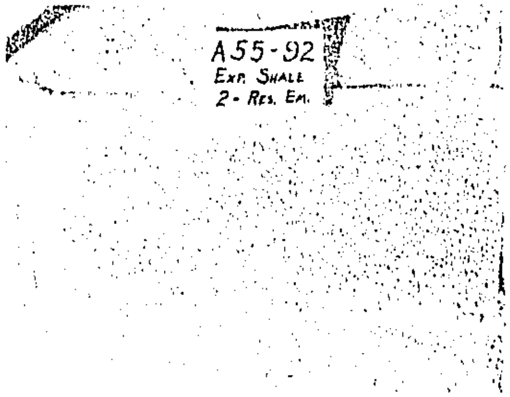


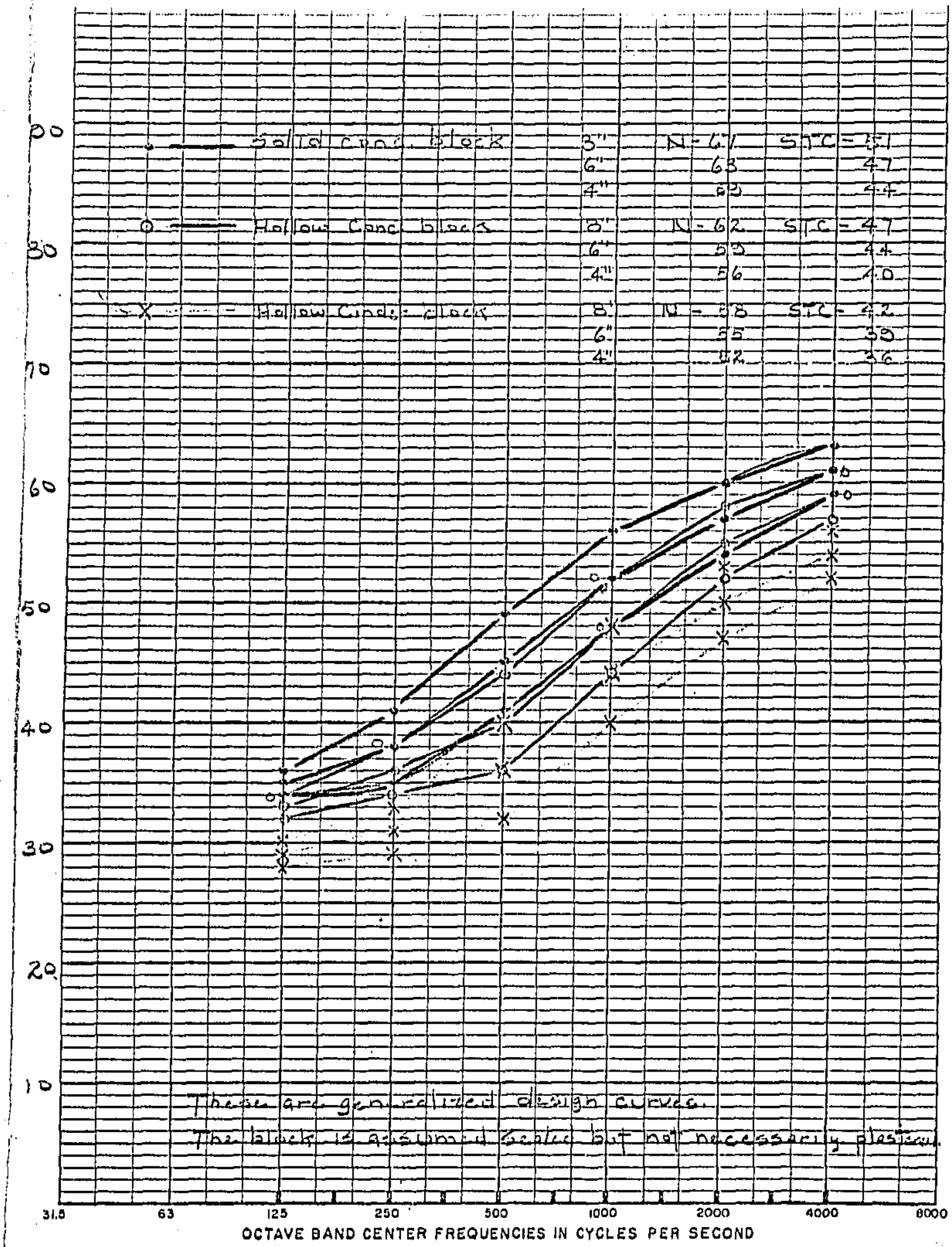
Fig. 18. Painted Expanded Shale Block Panel for Sound Absorption Test

It seems evident that heavy paint films which seal the surface pores of the block and thus decrease sound transmission will also significantly diminish the sound absorption value of the masonry.

Previous tests* have shown that decorative paint coatings applied by spraying or ordinary brushing do not fill the surface pores of block to the same extent as was the case in the sound transmission and sound absorption tests described in this report and, consequently, reduce the sound absorption coefficient by only five to ten percentage units.

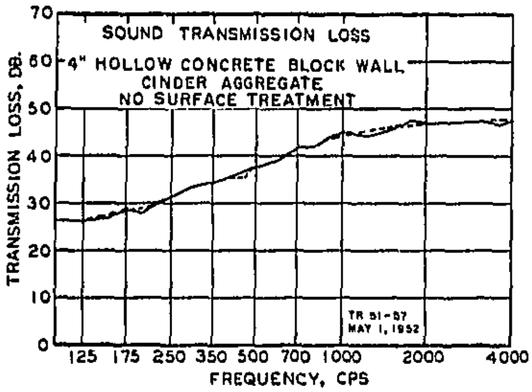
Accordingly, in the painting of concrete masonry walls it is possible to employ paint types and painting methods which reduce both sound transmission and sound absorption, but paint coatings which have little effect on one property will have little effect on the other.

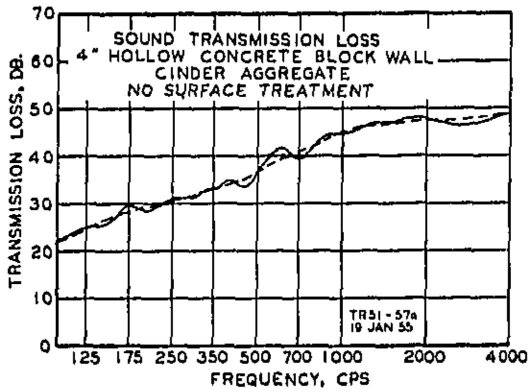
* See "Facts About Concrete Masonry" published by National Concrete Masonry Association.

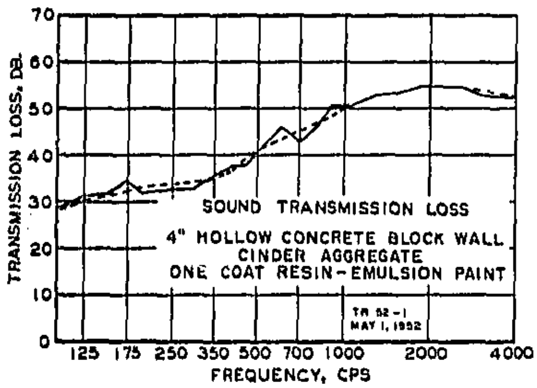

Solid Conc. block
6" 63 47
4" 44
Hollow Conc. block 8" N = 62 STC = 47
6" 44
4" 56 40
Hollow Cinder block 8" N = 58 STC = 42
6" 55 39
4" 36
These are generalized design curves.
The block is assumed
but not necessarily
10
20
30
40
50
60
70
80
90
31.5
63
125
250
500
1000
2000
4000
8000
OCTAVE BAND CENTER FREQUENCIES IN CYCLES PER SECOND

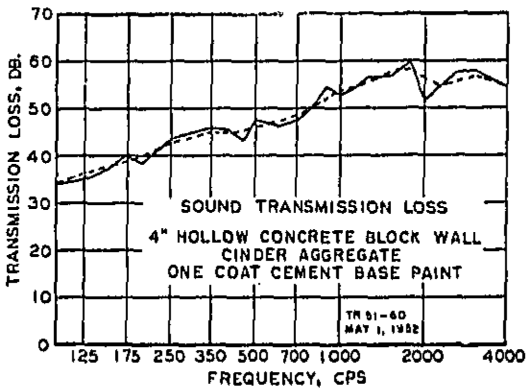
APPENDIX

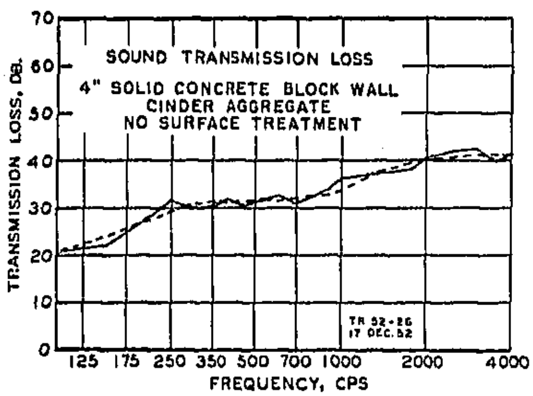
Individual Test Results

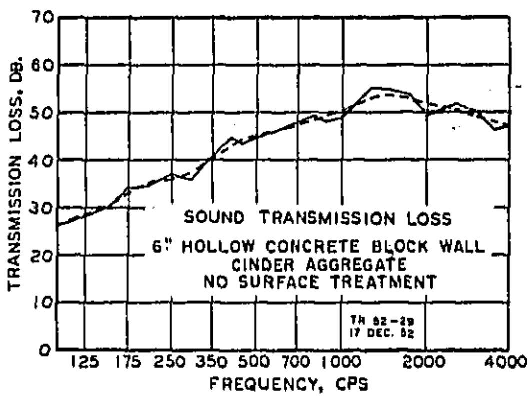

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
CINDER AGGREGATE
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 51-57
MAY 1, 1952

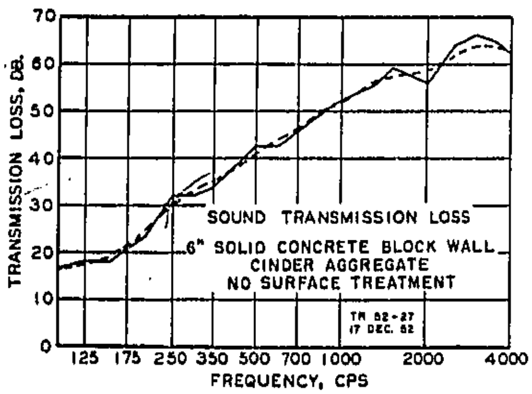

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
CINDER AGGREGATE
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR51-57a
19 JAN 55

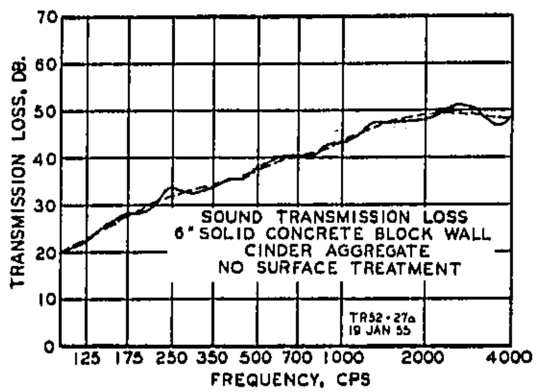

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
CINDER AGGREGATE
ONE COAT RESIN-EMULSION PAINT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 52-1
MAY 1, 1952

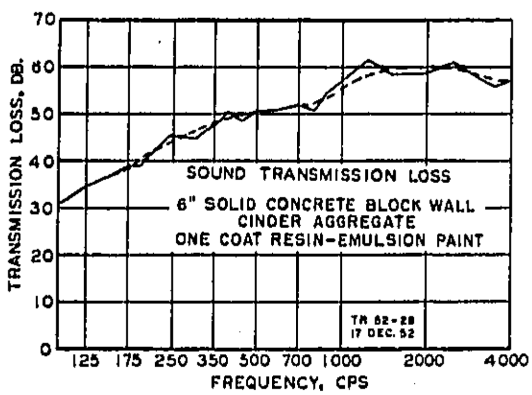

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
CINDER AGGREGATE
ONE COAT CEMENT BASE PAINT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 51-60
MAY 1, 1952

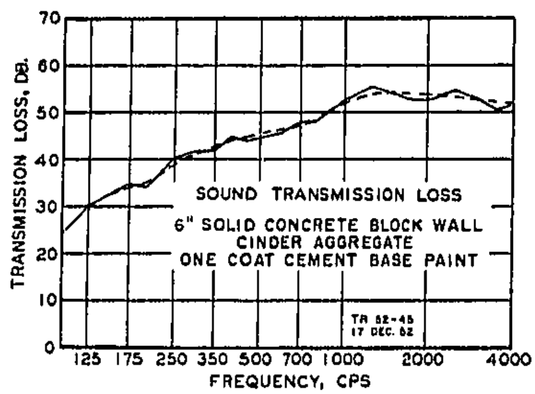

SOUND TRANSMISSION LOSS
4" SOLID CONCRETE BLOCK WALL
CINDER AGGREGATE
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 52-26
17 DEC. 52

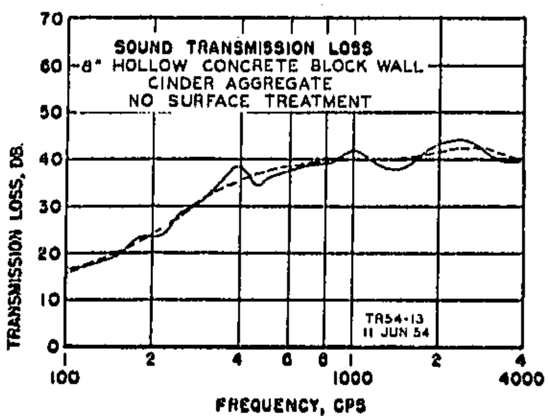

SOUND TRANSMISSION LOSS
6" HOLLOW CONCRETE BLOCK WALL
CINDER AGGREGATE
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 52-29
17 DEC. 52

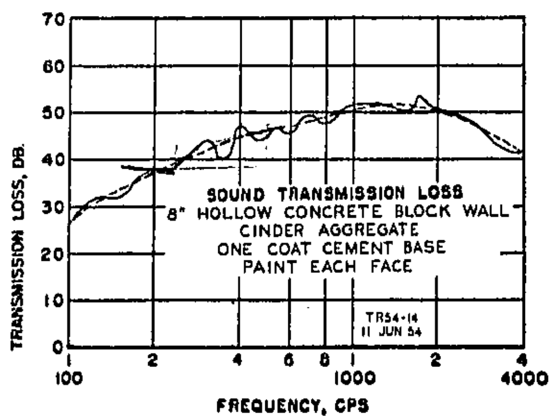

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
CINDER AGGREGATE
NO SURFACE TREATMENT
TR 52-27
17 DEC. 52
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

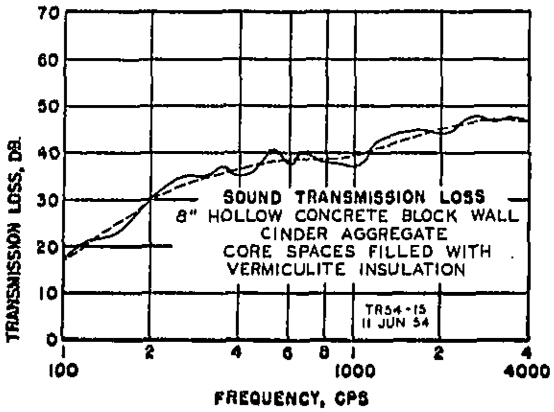

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
CINDER AGGREGATE
NO SURFACE TREATMENT
TR52-27a
19 JAN 55
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

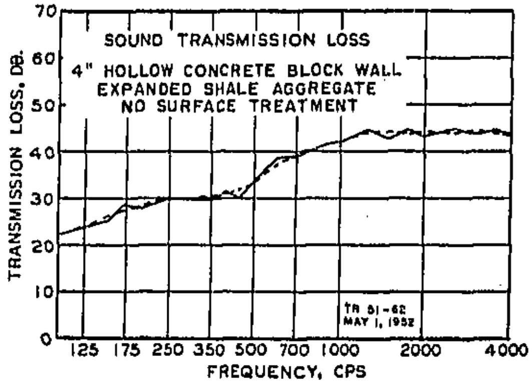

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
CINDER AGGREGATE
ONE COAT RESIN-EMULSION PAINT
TR 52-28
17 DEC. 52
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

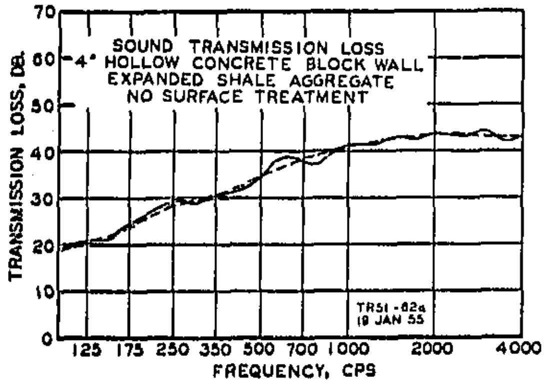

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
CINDER AGGREGATE
ONE COAT CEMENT BASE PAINT
TR 52-45
17 DEC. 52
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

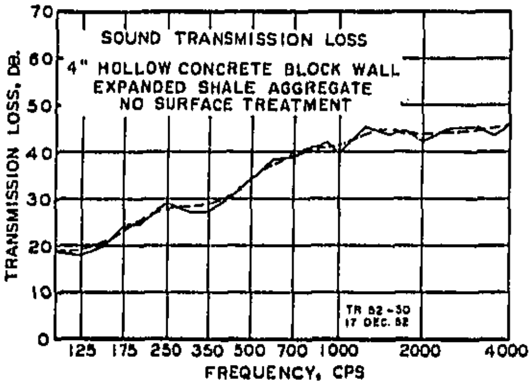

SOUND TRANSMISSION LOSS
8" HOLLOW CONCRETE BLOCK WALL
CINDER AGGREGATE
NO SURFACE TREATMENT
TR54-13
11 JUN 54
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

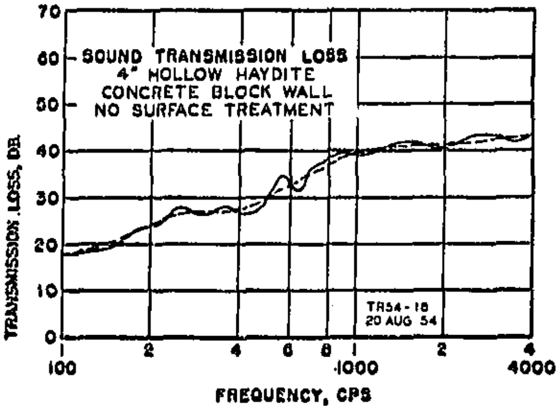

SOUND TRANSMISSION LOSS
8" HOLLOW CONCRETE BLOCK WALL
CINDER AGGREGATE
ONE COAT CEMENT BASE
PAINT EACH FACE
TR54-14
11 JUN 54
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

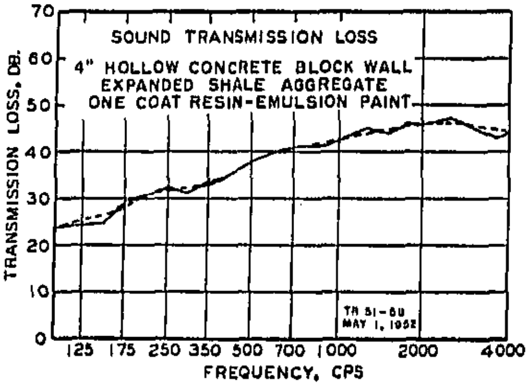

SOUND TRANSMISSION LOSS
8" HOLLOW CONCRETE BLOCK WALL
CINDER AGGREGATE
CORE SPACES FILLED WITH
VERMICULITE INSULATION
TR54-15
11 JUN 54
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

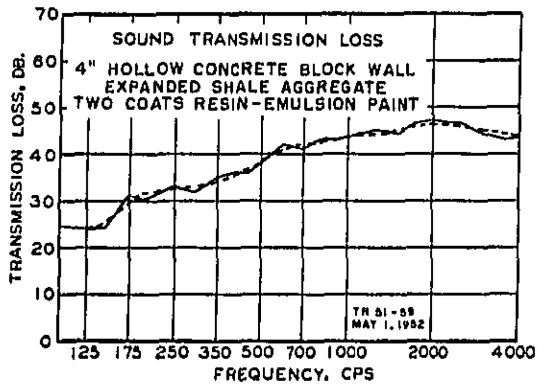

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
NO SURFACE TREATMENT
TR 51-62
MAY 1, 1952
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

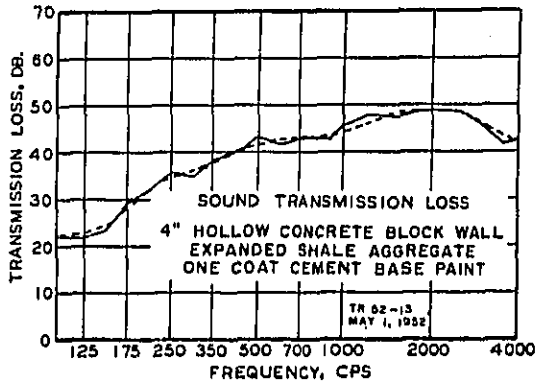

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
NO SURFACE TREATMENT
TR51-62a
19 JAN 55
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

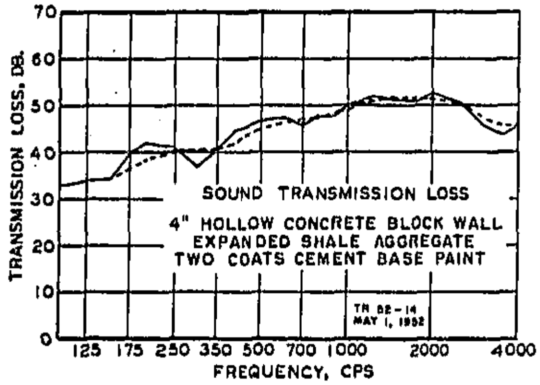

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
NO SURFACE TREATMENT
TR 52-30
17 DEC. 52
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

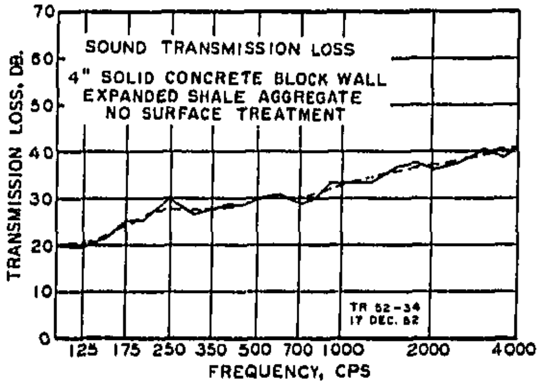

SOUND TRANSMISSION LOSS
4" HOLLOW HAYDITE
CONCRETE BLOCK WALL
NO SURFACE TREATMENT
TR54-18
20 AUG 54
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

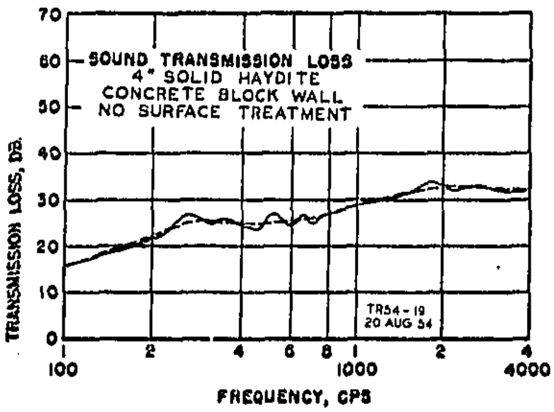

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
ONE COAT RESIN-EMULSION PAINT
TR 51-60
MAY 1, 1952
TRANSMISSION LOSS, DB.
FREQUENCY, CPS

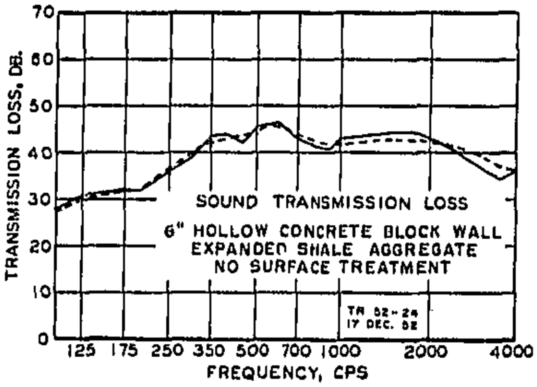

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
TWO COATS RESIN-EMULSION PAINT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
MAY 1, 1952

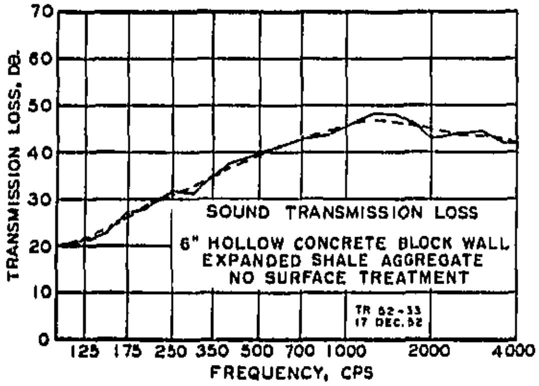

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
ONE COAT CEMENT BASE PAINT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 52-13
MAY 1, 1952

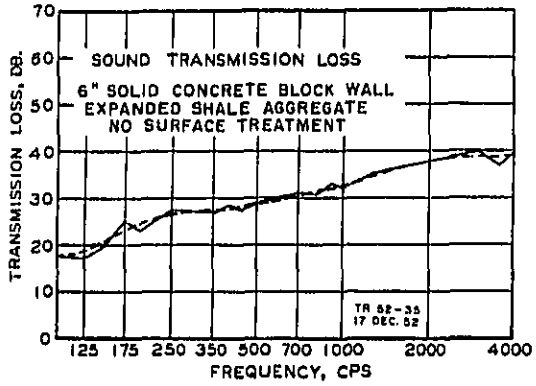

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
TWO COATS CEMENT BASE PAINT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 52-14
MAY 1, 1952

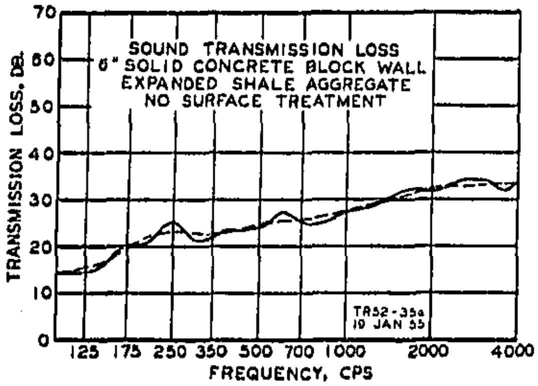

SOUND TRANSMISSION LOSS
4" SOLID CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 52-34
17 DEC. 52

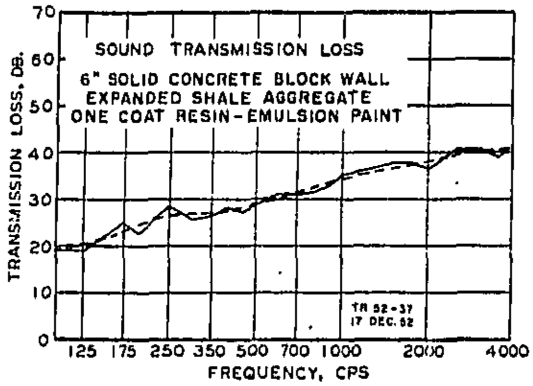

SOUND TRANSMISSION LOSS
4" SOLID HAYDITE
CONCRETE BLOCK WALL
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR54-19
20 AUG 54

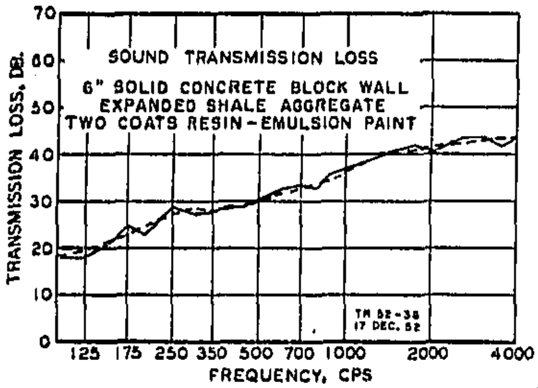

SOUND TRANSMISSION LOSS
6" HOLLOW CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 52-24
17 DEC. 52

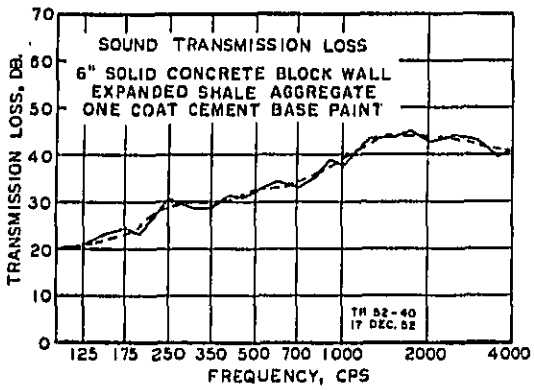

SOUND TRANSMISSION LOSS
6" HOLLOW CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
NO SURFACE TREATMENT
TR 52-33
17 DEC. 52
TRANSMISSION LOSS, DB.
0 10 20 30 40 50 60 70
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS

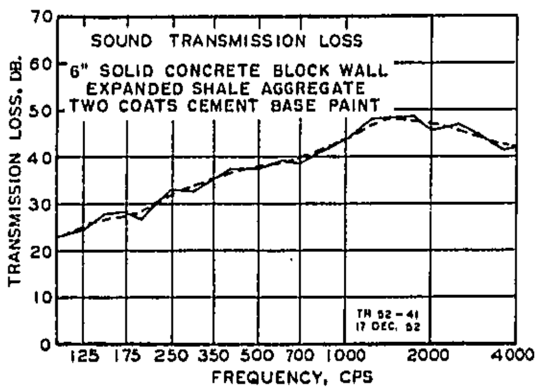

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
NO SURFACE TREATMENT
TR 52-35
17 DEC. 52
TRANSMISSION LOSS, DB.
0 10 20 30 40 50 60 70
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS

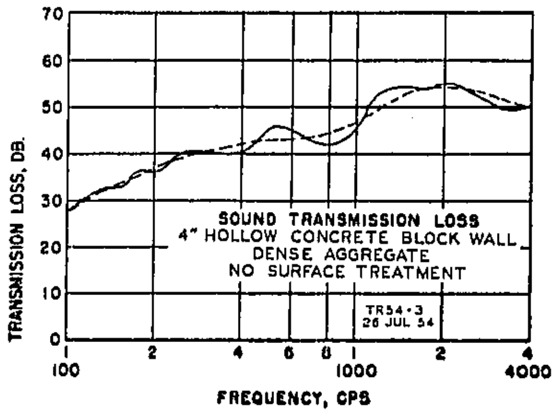

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
NO SURFACE TREATMENT
TR52-35a
10 JAN 55
TRANSMISSION LOSS, DB.
0 10 20 30 40 50 60 70
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS

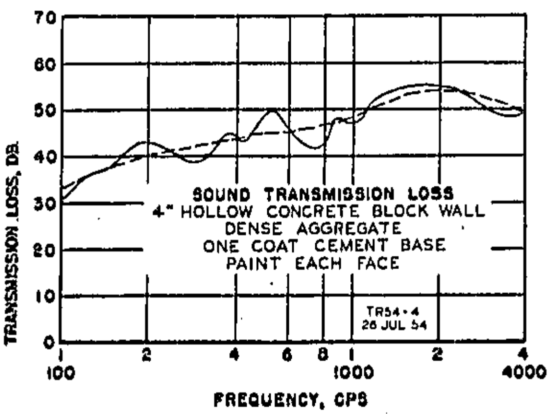

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
ONE COAT RESIN-EMULSION PAINT
TR 52-37
17 DEC. 52
TRANSMISSION LOSS, DB.
0 10 20 30 40 50 60 70
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS

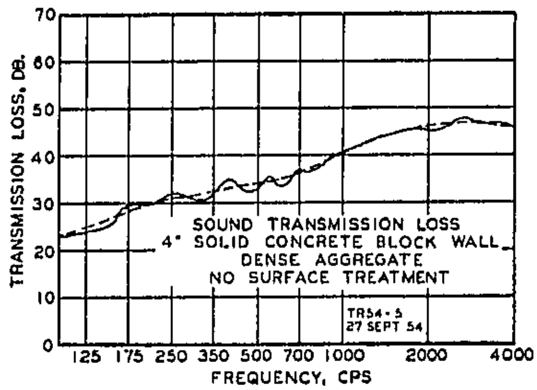

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
TWO COATS RESIN-EMULSION PAINT
TR 52-38
17 DEC. 52
TRANSMISSION LOSS, DB.
0 10 20 30 40 50 60 70
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS

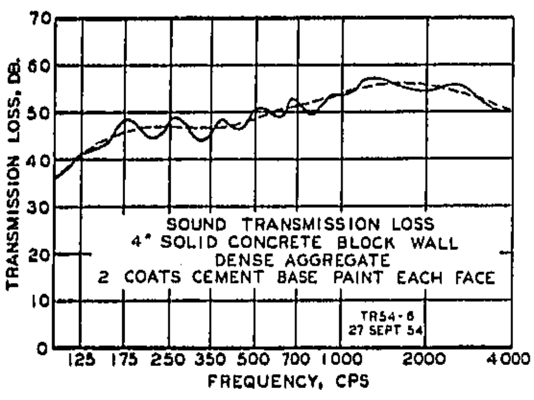

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
ONE COAT CEMENT BASE PAINT
TR 52-40
17 DEC. 52
TRANSMISSION LOSS, DB.
0 10 20 30 40 50 60 70
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS

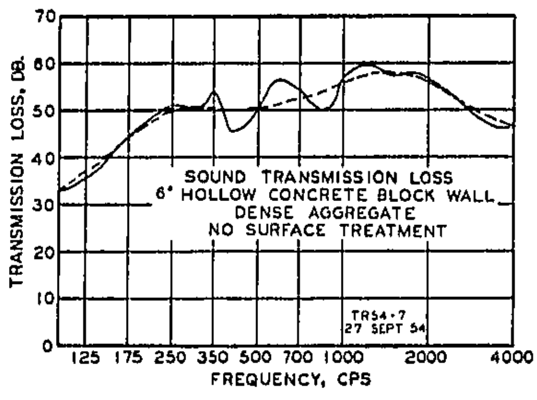

SOUND TRANSMISSION LOSS
6" SOLID CONCRETE BLOCK WALL
EXPANDED SHALE AGGREGATE
TWO COATS CEMENT BASE PAINT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR 52-41
17 DEC. 52

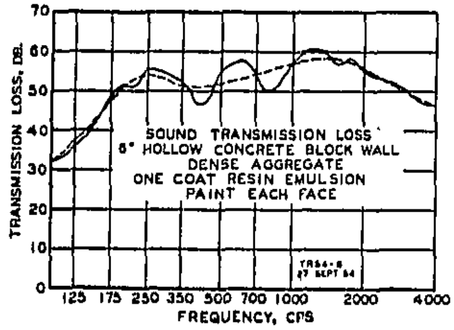

SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
DENSE AGGREGATE
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR54-3
26 JUL 54


SOUND TRANSMISSION LOSS
4" HOLLOW CONCRETE BLOCK WALL
DENSE AGGREGATE
ONE COAT CEMENT BASE
PAINT EACH FACE
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR54-4
26 JUL 54

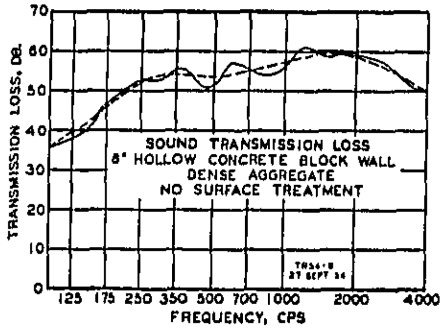

SOUND TRANSMISSION LOSS
4" SOLID CONCRETE BLOCK WALL
DENSE AGGREGATE
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR54-5
27 SEPT 54


SOUND TRANSMISSION LOSS
4" SOLID CONCRETE BLOCK WALL
DENSE AGGREGATE
2 COATS CEMENT BASE PAINT EACH FACE
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR54-6
27 SEPT 54

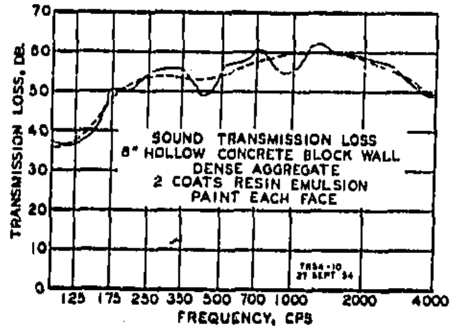

SOUND TRANSMISSION LOSS
6" HOLLOW CONCRETE BLOCK WALL
DENSE AGGREGATE
NO SURFACE TREATMENT
TRANSMISSION LOSS, DB.
FREQUENCY, CPS
TR54-7
27 SEPT 54



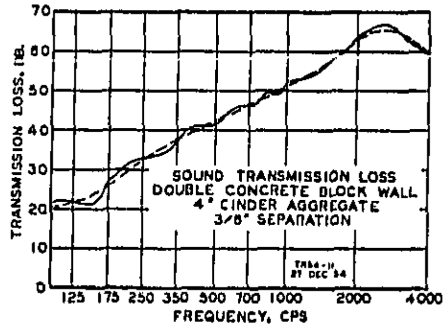
TRANSMISSION LOSS, DB.
70
60
50
40
30
20
10
0
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS
SOUND TRANSMISSION LOSS
8" HOLLOW CONCRETE BLOCK WALL
DENSE AGGREGATE
ONE COAT RESIN EMULSION
PAINT EACH FACE



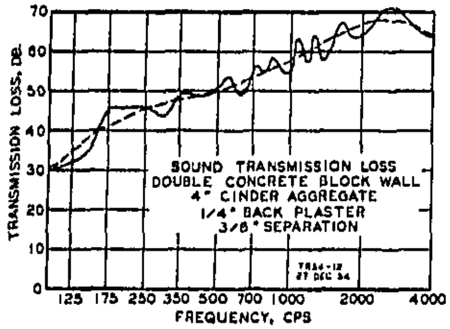
TRANSMISSION LOSS, DB.
70
60
50
40
30
20
10
0
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS
SOUND TRANSMISSION LOSS
8" HOLLOW CONCRETE BLOCK WALL
DENSE AGGREGATE
NO SURFACE TREATMENT



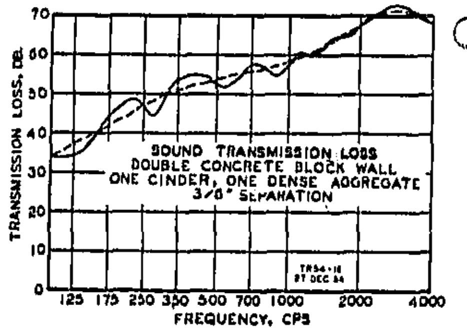
TRANSMISSION LOSS, DB.
70
60
50
40
30
20
10
0
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS
SOUND TRANSMISSION LOSS
8" HOLLOW CONCRETE BLOCK WALL
DENSE AGGREGATE
2 COATS RESIN EMULSION
PAINT EACH FACE



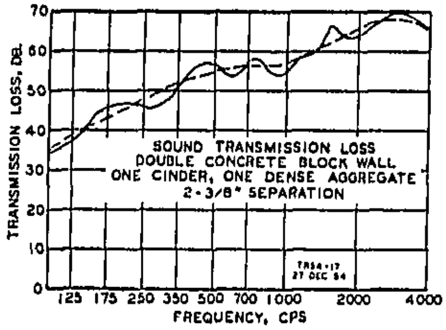
TRANSMISSION LOSS, DB.
70
60
50
40
30
20
10
0
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS
SOUND TRANSMISSION LOSS
DOUBLE CONCRETE BLOCK WALL
4" CINDER AGGREGATE
3/8" SEPARATION



TRANSMISSION LOSS, DB.
70
60
50
40
30
20
10
0
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS
SOUND TRANSMISSION LOSS
DOUBLE CONCRETE BLOCK WALL
4" CINDER AGGREGATE
1/4" BACK PLASTER
3/8" SEPARATION



TRANSMISSION LOSS, DB.
70
60
50
40
30
20
10
0
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS
SOUND TRANSMISSION LOSS
DOUBLE CONCRETE BLOCK WALL
ONE CINDER, ONE DENSE AGGREGATE
3/8" SEPARATION



TRANSMISSION LOSS, DB.
70
60
50
40
30
20
10
0
125 175 250 350 500 700 1000 2000 4000
FREQUENCY, CPS
SOUND TRANSMISSION LOSS
DOUBLE CONCRETE BLOCK WALL
ONE CINDER, ONE DENSE AGGREGATE
2-3/8" SEPARATION