National Research Council Canada
Conseil national de recherches Canada

Institute for Research in Construction
Institut de recherche en construction

Sound Transmission Loss Measurements Through 190 mm and 140 mm blocks with Added Drywall and Through Cavity Block Walls.

By A.C.C. Warnock

Internal Report No. 586

Date of Issue: January 1990

Canada

Summary

This report presents the results of a series of sound transmission loss measurements carried out under contract for the Ontario Concrete Block Association.

The test series was augmented for research purposes by measuring sound transmission losses at different stages in the construction and disassembly of the walls. The report that follows provides an analysis of the information obtained during the complete measurement series.

Résumé

Ce rapport présente les résultats d'une série de mesures de perte de transmission sonore réalisées contrat pour le compte de l'Ontario Concrete Block Association. Le CNRC a complété la série d'essais, à des fins de recherche, en mesurant la perte de transmission sonore à différent stades de construction et de démontage des murs. Ce rapport renferme une analyse de l'information obtenue lors de la réalisation de toute la série de mesures.

The major findings of the study are as follows:

Concrete block walls are capable of providing high sound insulation at low frequencies if layers of drywall are added to them in the correct fashion. Sound transmission class ratings as high as 73 were obtained for a single wythe 190 mm block wall. To achieve such high values, appropriate drywall mounting techniques and cavity depth must be selected. Sound absorbing material in the cavity significantly increases sound insulation without changing wall thickness.

A simple method of predicting sound transmission loss for certain block wall systems was developed. This was used to predict sound transmission for walls with concrete blocks of other common thicknesses.

In theory, two-leaf block walls have the potential to provide very high values of sound transmission class and did so in the laboratory tests (STC 79 was measured in one case). To achieve high performance in practical situations, very careful design and construction are required.

Similar work needs to be done with lightweight, more porous blocks; there is some evidence that more porous blocks increase effective cavity depths. Thus, it might be possible to achieve high STC and good low-frequency performance with lightweight blocks.

Introduction

A knowledge of the factors that control sound transmission through block wall systems is important for the economical control of noise in buildings. Noise sources in neighboring homes include stereos, voices and television. Mechanical equipment next to living areas is also a frequent source of complaint and needs to be controlled.

Despite the fact that block and other types of walls have been in use for many years, there was a need for new measurements on block walls. There were several reasons for this.

> There are discrepancies among the data presented in the literature for nominally identical blocks with and without finished surfaces. Some of these can be ascribed to improvements in measurement techniques that render old data obsolete, some to differences in installation details and laboratory facilities, and some to other unidentified physical factors.
>
> Sound insulation requirements in the 1990 National Building Code of Canada are to be increased relative to earlier versions and there is a general demand for greater sound insulation in homes. Some jurisdictions in Canada are asking for sound transmission class ratings of 55 or better. Not enough information is available to allow the economical selection of block walls with high values of sound attenuation.
>
> There is increasing recognition that low frequency sound, below the limit normally measured in tests, is the major cause of complaint in buildings. Only a few laboratories have begun to collect sound transmission information at low frequencies, because not all have the required laboratory facilities to collect reliable data.
>
> There is a lack of information on block wall systems with very high STC ratings. This is despite the fact that it is relatively simple to get such ratings and that block walls are often the system of choice for reducing high levels of noise from machine rooms.

For these reasons, the series of measurements that are described in what follows was undertaken.

The major part of the work was a series of measurements to study the influence on the sound transmission loss of different methods of attaching single layers of drywall to blocks. A short test series was run on 75% and 100% solid, 140 mm concrete blocks. As well, measurements were made on cavity block walls to determine the effects of different thermal insulation in the cavity and to determine the importance of flanking sound transmission through the laboratory test frame.

The transmission losses for all constructions together with information on the materials and construction techniques used can be found in the Appendices.

Block walls with no surface finish

The major factor controlling the sound transmission through a single wythe wall is the weight per unit area. The stiffness and thickness of the wythe, however, are also important. Simple theory predicts that sound transmission loss, and therefore the STC, will increase by about 5 decibels each time the weight of the wall is doubled.

Figure 1 shows measured sound transmission class (STC) ratings for single wythe block walls from a number of sources in the literature.

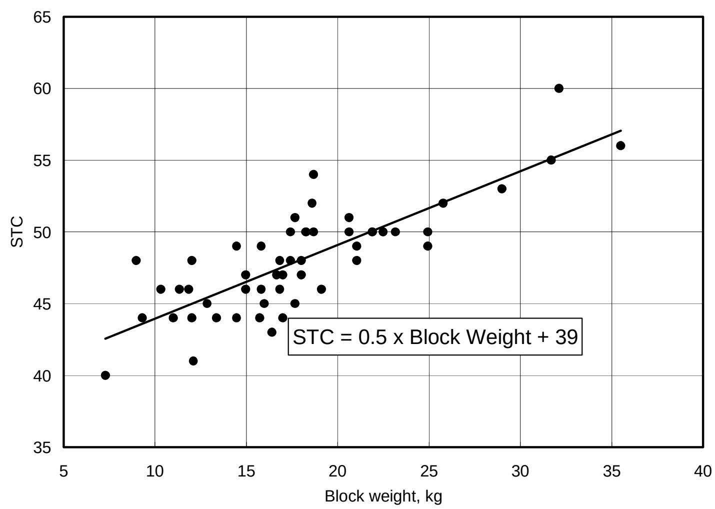

Figure 1: Relationship between sound transmission class and the weight of the blocks used to construct a single layer wall.

Previous work has shown that where the block is porous, sealing the surface can have a significant effect on the sound transmission: the more porous the block, the greater the increase in sound transmission loss. The air flow resistance of a material, related to the porosity, can be measured relatively easily; unfortunately, it is not customary to measure this quantity when sound transmission for block walls is being evaluated.

The walls selected for Fig. 1 were thought to have little or no sound leaking through the pores of the blocks. Nevertheless, the scatter in the diagram is still large and there may be some points representing leaky structures. The STC is plotted against the block weight. Simple theory suggests that the logarithm is a more appropriate variable. Regression analysis of this data set shows, however, that the goodness of fit is about the same. Block weight is usually more readily available, so the plot is presented as shown. It is clear that the surface mass is not a good enough predictor.

The combination of the effects of weight, stiffness, porosity, and the shape of normal hollow block is too complicated to allow simple theoretical prediction of sound transmission loss. One has to fall back on empirical approaches and measurement.

190 mm blocks with attached drywall

The goal of this part of the work was to study the effects of different methods of attaching drywall to a 190 mm block wall. Figure 2 shows schematically the methods that were used. These included some common techniques (resilient channels, wood furring, 65 mm steel studs) and alternatives that are not in common use (50 and 75 mm Z-bars). For each method of attachment, the wall was tested with the cavity empty and with it filled with sound-absorbing material. The range of cavity depths was chosen to cover all likely practical cases. In this figure and in the tables that follow, a coded method of describing wall constructions is used. The coding is explained in Appendix A2.

Figure 2: Techniques used to attach drywall to the block walls. In each case the walls were tested with and without glass fibre in the cavity.

Mass-air-mass resonance

The addition of layers of drywall to the surfaces of a block wall creates a cavity behind the drywall. Theory predicts that walls with unfilled cavities will resonate at a frequency that is determined by

$$f_{mam} = \frac{60}{\sqrt{md}}$$

where m is the mass per unit area of the drywall, kg/m^2, and d is the distance from the drywall to the block surface, m.

The mass per unit area of the block, because it is so much greater than that of the drywall, does not affect the location of the resonance frequency.

Near this resonance, sound transmission losses are reduced below those for the unfinished wall. The mass-air-mass resonance frequency usually occurs at low frequencies and is often the reason for a reduction in the STC when extra layers of drywall are added to the block wall. The greater the depth of the cavity, the lower the frequency at which the resonance occurs. Alternatively, increasing the weight of the drywall layer also lowers the resonance frequency. Lowering the mass-air-mass resonance frequency usually increases STC. The frequency and the depth of the resonance are important pieces of information for designing block walls.

Effect of sound absorbing material on mass-air-mass resonance

Adding sound absorbing material to the cavity behind the drywall lowers the resonance frequency. The behavior of the air in the cavity changes from adiabatic to isothermal and the position of the mass-air-mass resonance is now given by

$$f_{mam} = \frac{43}{\sqrt{md}}$$

Sound absorbing material will also damp resonances in the cavity and reduce their effect. This applies to the mass-air-mass resonance and other cavity resonances that occur at higher frequencies. Since the mass-air-mass resonance occurs at low frequencies, however, where sound absorbing materials are less effective, the damping effect of absorbers at low frequencies may be slight if the cavity is not deep.

Figure 3 gives some results for walls with unfilled cavities. Increasing cavity depth clearly leads to a shift in the mass-air-mass resonance to lower frequencies as predicted. It is also clear that the mass-air-mass resonance can seriously reduce the sound transmission loss of the wall at the important low frequencies, even if this does not always result in a lower STC.

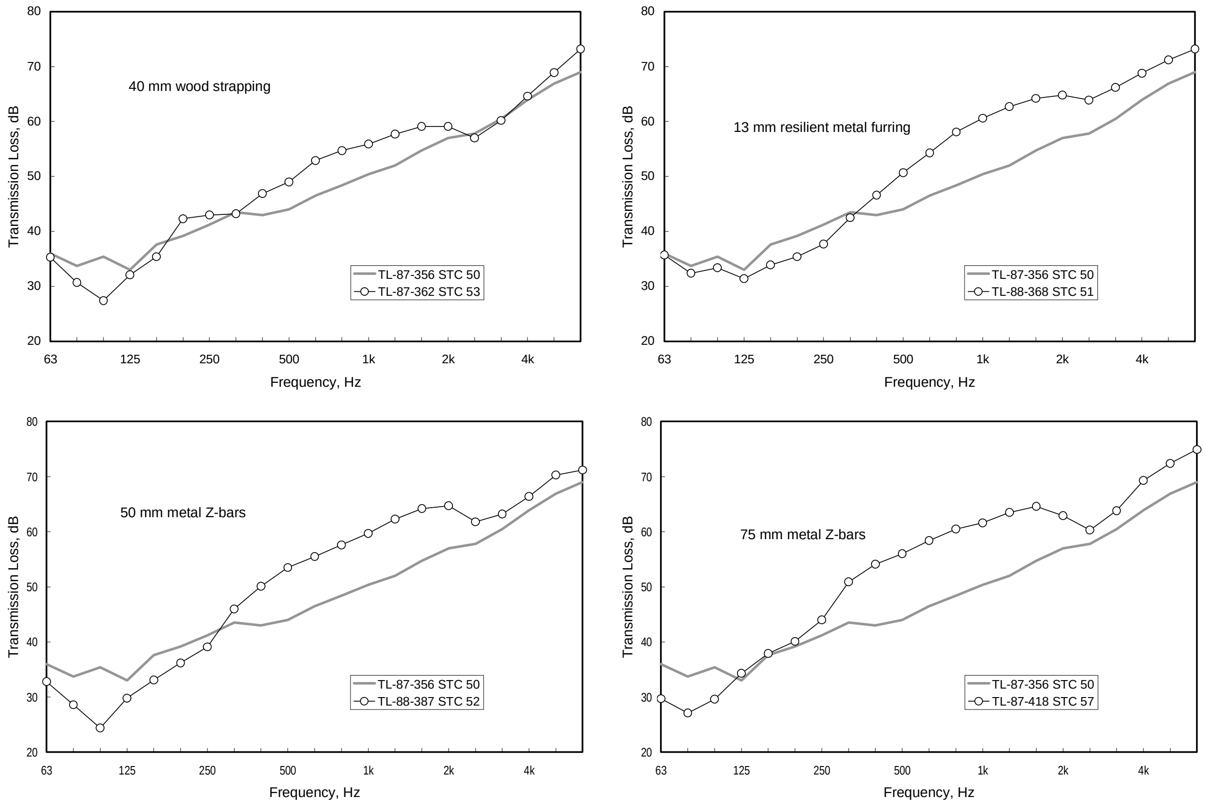

Figure 3: Transmission loss measurements for wall with drywall attached on one side only. There is no sound-absorbing material in the cavity. The gray curve in each case is the result for the bare 190 mm blocks.

Figure 4 shows results for walls with the same drywall mounting method used and the cavity filled and unfilled with absorptive material. As expected, the mass-air-mass resonance moves to a lower frequency and the transmission loss curve appears to move sideways to lower frequencies. The result is improved STC ratings and improved sound transmission loss at low frequencies.

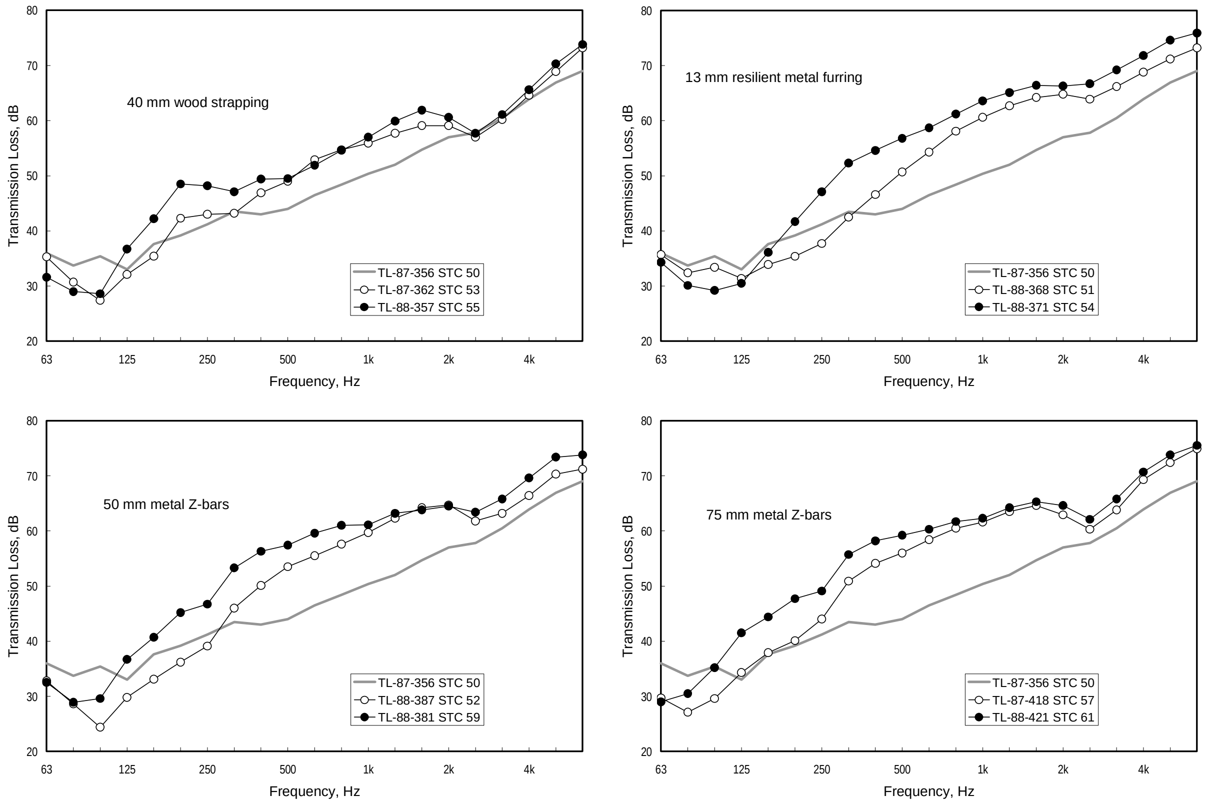

Figure 4: Transmission loss measurements for walls with drywall attached on one side only. The open circles are for the cavity unfilled, the closed circles are for the cavity filled with sound-absorbing material. The gray curve in each case is the result for the bare 190 mm blocks.

Prediction of sound transmission through block walls with attached drywall.

While no comprehensive theory exists to predict the sound transmission through block walls, some simple models suggest that the effects of additional layers can be found by simply adding terms to the sound transmission loss values for the bare wall. For example, each time a layer of drywall supported on resilient channels is added to a bare block wall surface, it will have the same relative effect no matter what is on the other side of the wall.

To illustrate the idea, Fig. 5 shows results for walls with one side and two sides treated. The addition of the second layer further improves transmission loss at higher frequencies and further reduces it at lower frequencies. The supposition is that, on average, the change from the bare wall to one side treated is the same as the change from one side treated to both sides treated.

In the sections that follow, this approach to prediction is described and the results of the prediction are presented.

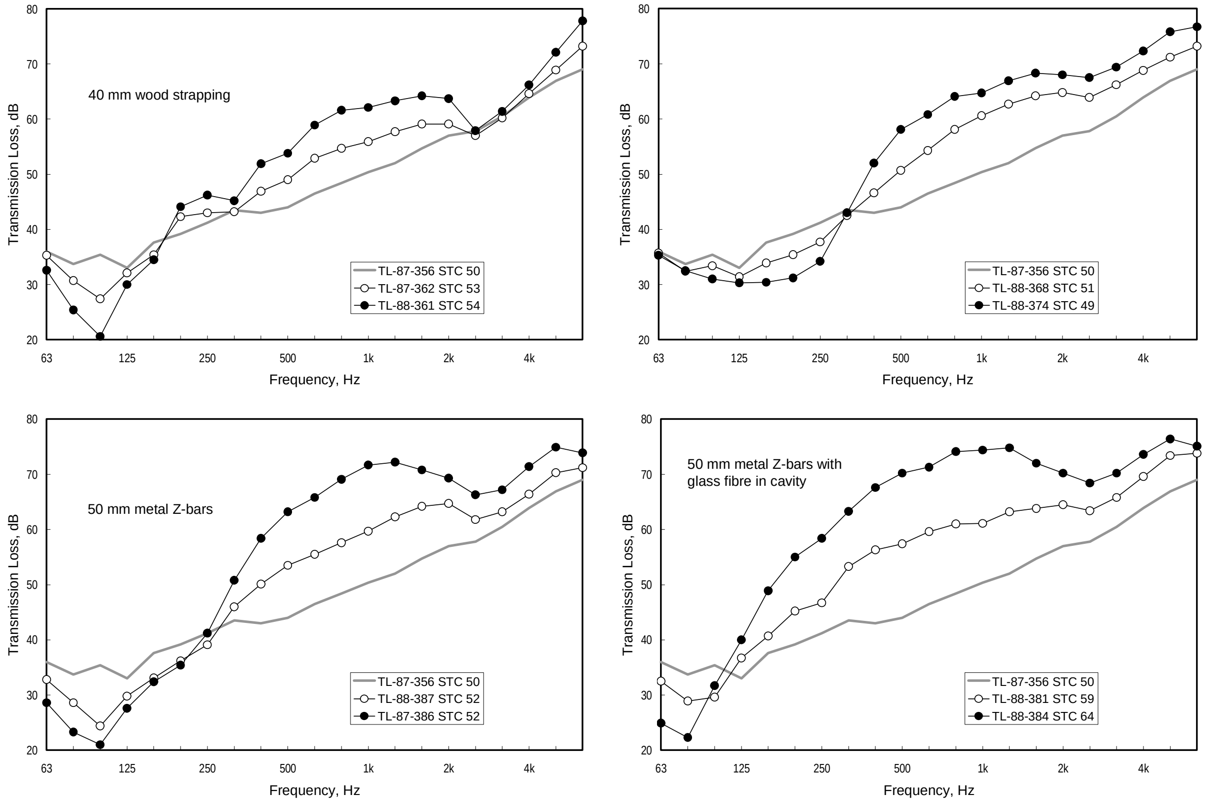

Figure 5: Transmission loss measurements for walls with drywall attached on one side (open circles) and on both sides (closed circles). The gray curve in each case is the result for the bare 190 mm blocks.

Derivation of difference TL curves

Table 1 shows the measured STC values for all the 190 mm block walls that were tested. Walls in the first column had only one side finished. Walls on the diagonal had both sides finished in the same way. Other walls had mixed finishes that can be identified from the row and column headings in the table.

Table 1: Measured STC ratings for 190 mm block wall systems tested.
Letter codes identify methods of attaching 16 mm drywall.

		Bare	A	B	C	D	E	F	G	H	I
	Bare	50									
A	**Direct**	50	49								
B	**WS38**	53		54							
C	**WS38_GFB38**	55	57	58	59						
D	**RC13**	51			58	49					
E	**RC13_GFB19**	54				52	49				
F	**ZC50**	52	52					52			
G	**ZC50_GFB50**	59					59	59	64		
H	**SS65**	58								57	
I	**SS65_GFB65**	60	61							65	72
J	**ZC75**	57	57							59	68
K	**ZC75_GFB75**	61	62	66							73

To calculate the difference in transmission loss due to a particular surface treatment, the sound transmission loss values for the bare block were subtracted from the sound transmission loss values for the walls in the first column. The bare block results were also subtracted from the diagonal entries and the result divided by two. Other combinations were found in the table to get the difference-TL curve for each surface treatment. The results for each surface finish were averaged.

Figure 6 gives examples of the difference curves for four of the drywall mounting methods tested. Table 2 lists the difference TL values for all cases.

Prediction of STC

The difference spectra listed in Table 2 were used to predict the measured sound transmission losses and STC for each mounting method shown in Fig. 2. The appropriate difference contours were added to the TL result for the bare block in each case. Figure 7 compares the predicted and measured STC ratings for all measured 190 mm walls. The agreement is very good; of the 31 predictions, 15 agreed exactly with measurement, 11 were wrong by 1 point and 5 were wrong by 2 points.

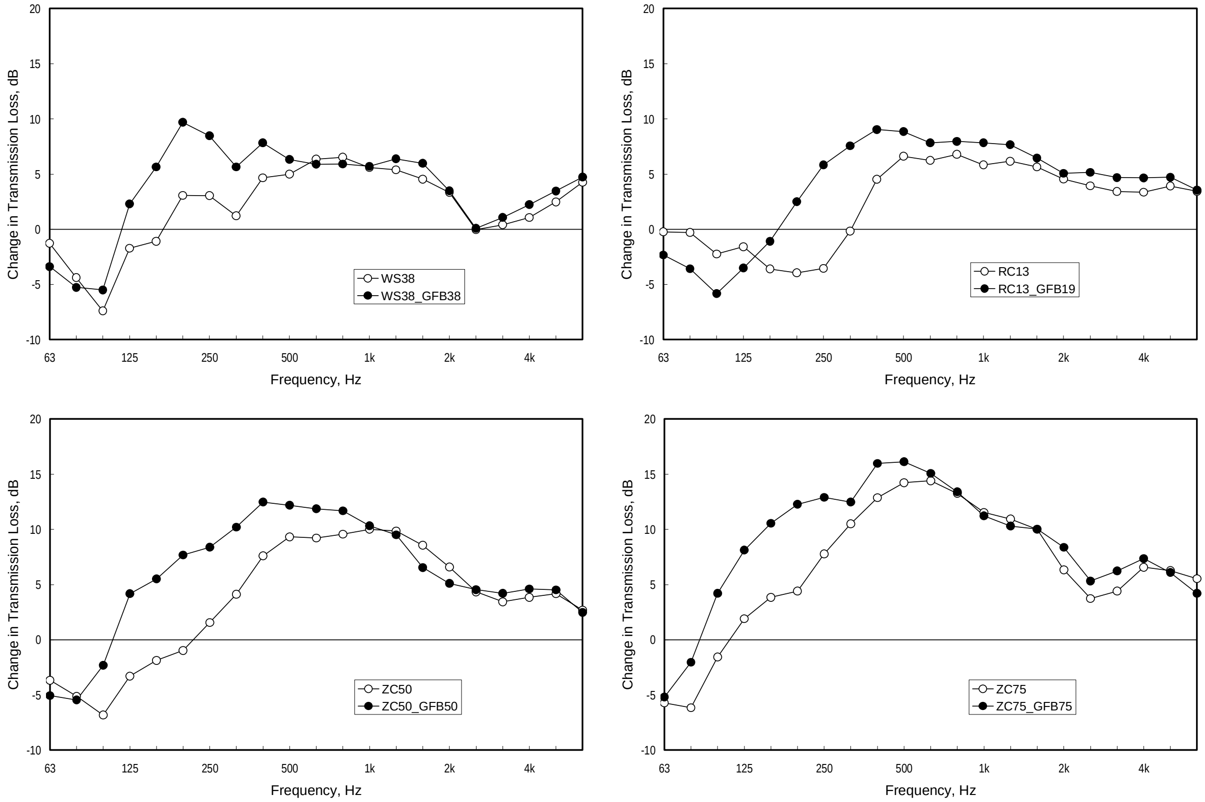

Figure 6: Average difference in transmission loss between the bare wall and the wall with different surface finishes on one side only. The open circles are for the cavity unfilled, the closed circles are for the cavity filled with sound-absorbing material.

Prediction of TL curve

While the agreement between measured and predicted STC ratings is satisfactory, the agreement between measured and predicted transmission loss values is also important. If the important low frequency values are not properly predicted, this method has no value.

Figure 8 shows examples of the agreement between the measured and predicted transmission loss curves. For practical estimates, the agreement is quite satisfactory.

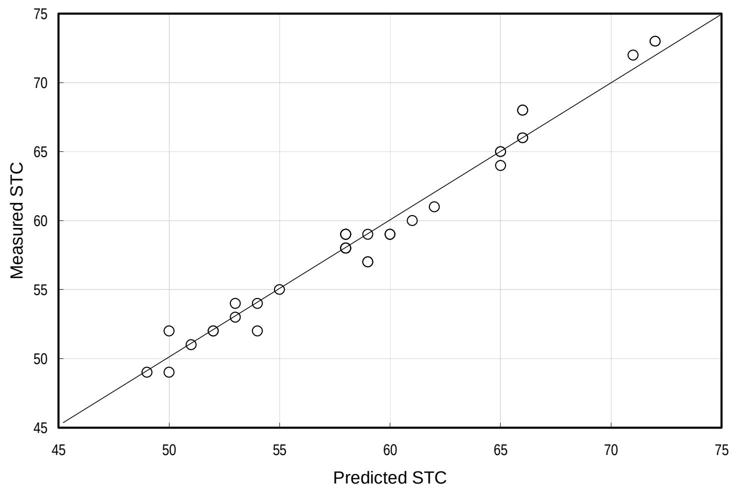

Figure 7: Comparison of the measured sound transmission class rating with that calculated using the addition method described in the text. The straight line shows where the two values are equal.

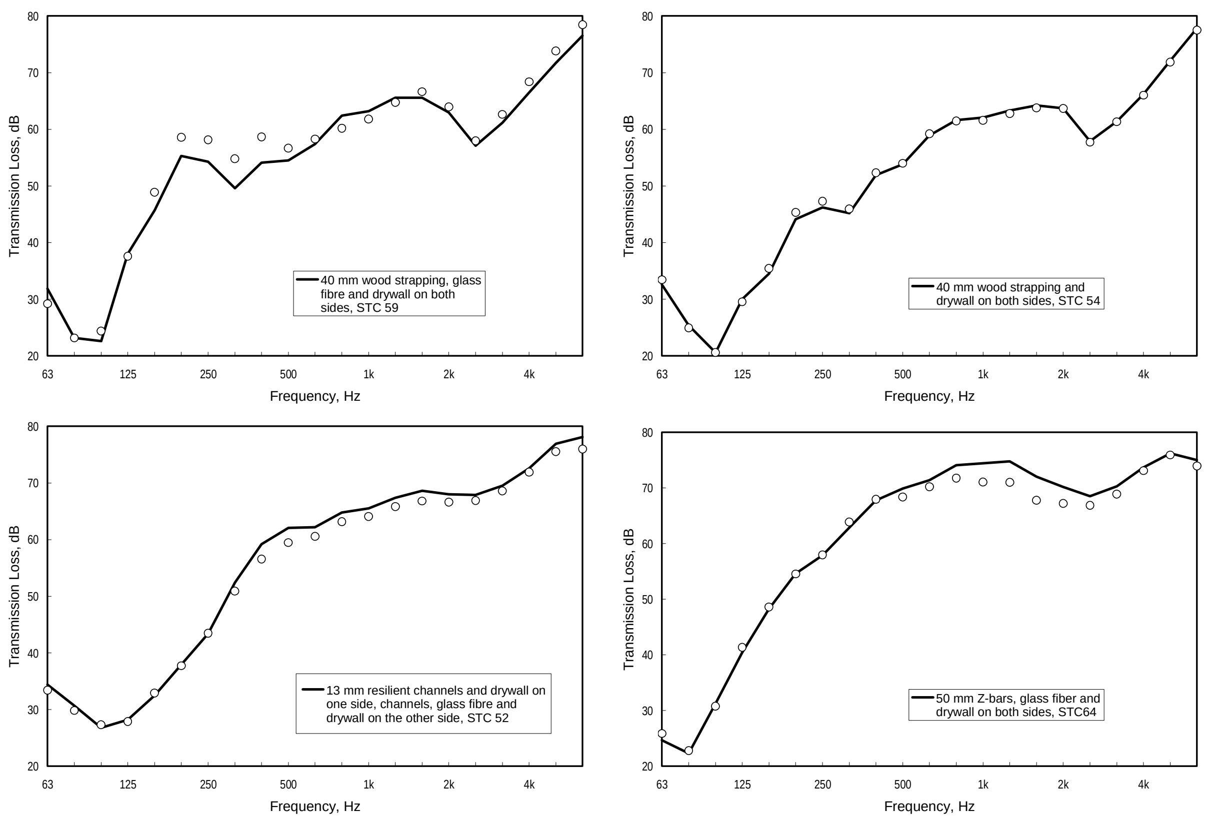

Figure 8: Comparison of predicted (o) and measured transmission loss (solid line) for 190 mm block walls.

Application of prediction scheme to other blocks

While this is not a rigorous prediction scheme, it has benefits of which can now be discussed.

Because the position of the mass-air-mass resonance is not affected by the block weight, the difference-TL curve for each drywall mounting method should be the same for any normal hollow block of whatever thickness. An important assumption here is that the porosity of the block is about the same in each case. If this is the case, then the difference-TL curves can be added to the measured sound transmission loss curve for other normal-weight bare blocks and sound transmission loss values predicted for all the mounting methods used in this study. The measurements on 140 mm blocks described below provided an opportunity to test this hypothesis.

140 mm blocks with added drywall

Two types of 140 mm block were measured, a 75% solid block and a 100% solid block. The configurations tested gave an opportunity to test the validity of the prediction scheme described above. As with the 190 mm blocks, there were no significant changes to the TL values after the blocks were painted. Figure 9 shows the measured and predicted TL values for the four configurations. The predicted STC in each case is 1 point lower than that measured, which is acceptable agreement. In cases b, c, and d, 13 mm drywall was used in the construction instead of 16 mm drywall. The ratings are determined by the TL values from about 200 to 800 hertz and, it is clear from the figure that the predicted values are slightly too low in this region and markedly lower at higher frequencies. Nevertheless, the overall agreement is fairly good, especially in the important low-frequency range.

Predicted STC ratings for 90, 140, 190, 240, and 290 mm normal weight blocks are given in Tables 3 to 9.

Conclusions for attached drywall series.

The correct choice of cavity depth and the addition of sound absorbing material ensures that sound transmission loss values are not degraded in the frequency range that is important to the end user. Conversely, a wrong choice results in a reduction in performance despite the addition of the extra material to the basic block wall.

Further work is need to examine the differences between lightweight and normal weight blocks. There is some evidence in the literature that block porosity increases the effective cavity depth. This raises the possibility that lightweight block systems might perform as well as normal weight block systems. Measurements in the literature from other laboratories do not extend to low frequencies, so the differences between the block types can not be evaluated without further extended measurements of the type described here.

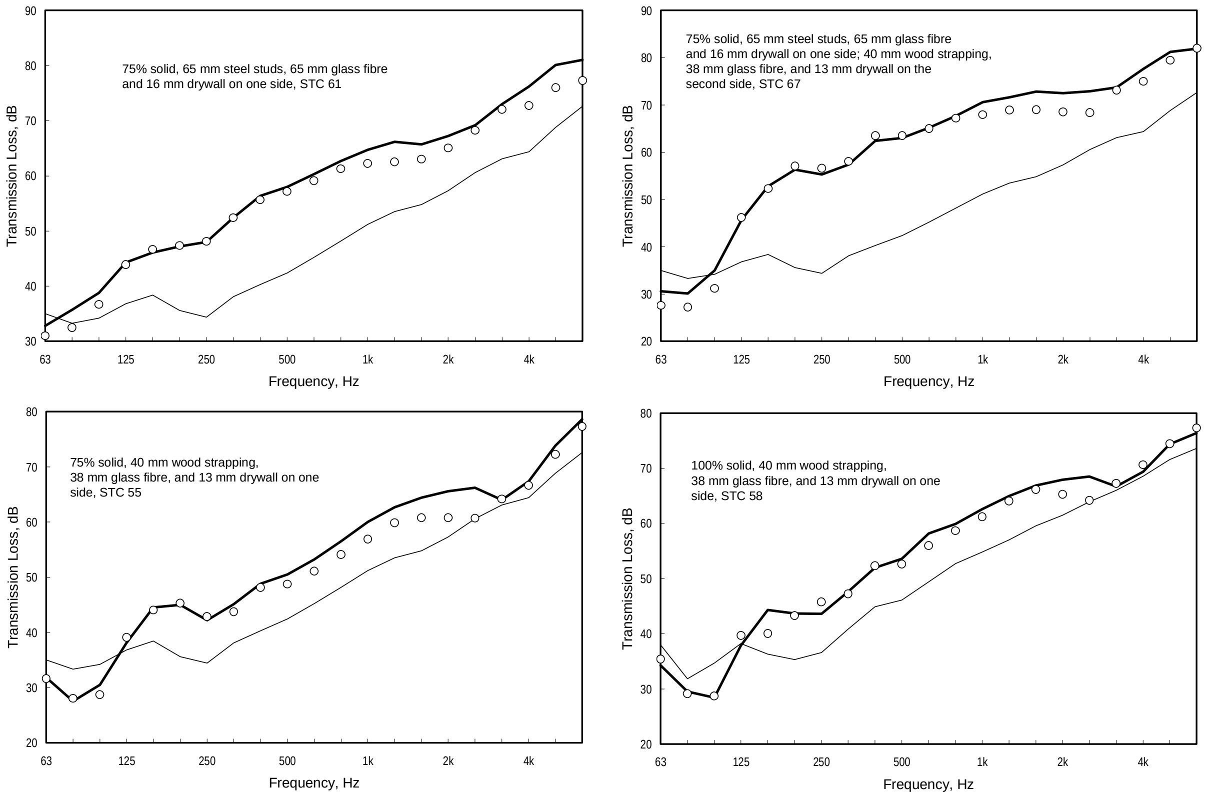

Figure 9: Comparison of predicted (o) and measured transmission loss (solid line) for 140 mm block walls.

Cavity block walls

A cavity block wall with no connections between the wythes should have sound transmission loss values much greater than a single wythe wall of the same total weight. Both layers are heavy, so the mass-air-mass resonance should occur at very low frequencies and there should be no reduction in sound transmission loss in the frequency range normally used for measurement. Against this, one must weigh the practical difficulties associated with constructing two block wythes that are not connected. In practice, there is always some transmission of energy around the periphery of the walls and through other parts of the structure. It requires careful design to reduce this flanking transmission; it can not be eliminated in practical cases. Where wire ties are used to bind the two wythes of the wall together, clearly there will be a significant reduction in performance because of transmission through the ties.

Measurements in the laboratory provide an opportunity to look at the effects of flanking transmission, at least in a qualitative way.

Room/test frame mounting results - 190/90 mm blocks

Figure 10 gives a cross section of the wall test opening in the laboratory. Normally, test specimens are mounted on the test frame and do not rigidly contact the rooms on either side. During this series, a split rib block wall was constructed on the receiving room lip as shown in the figure. Since both reverberation rooms are mounted on steel springs, this mounting technique provides the least amount of flanking transmission that can be achieved in the laboratory and is far better than could be achieved in normal field installations.

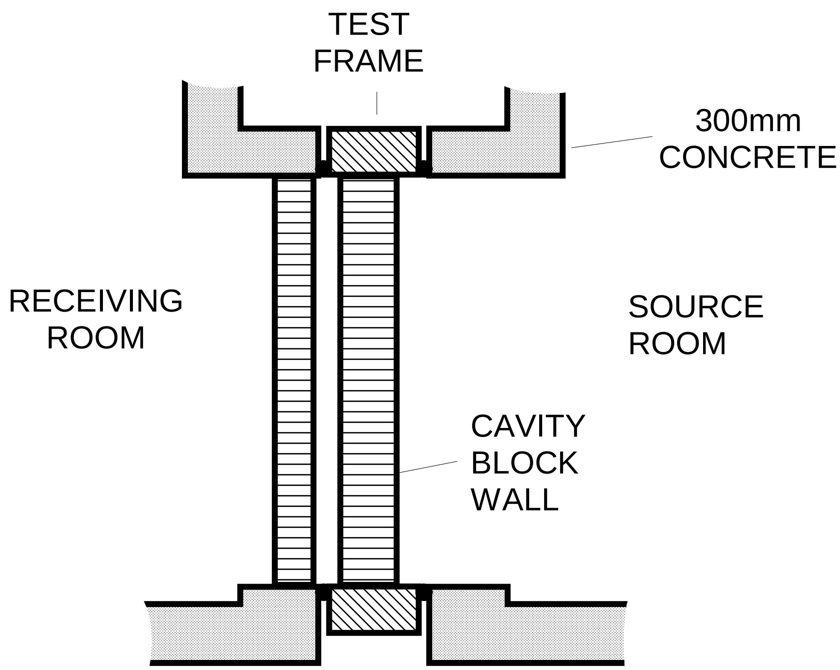

Figure 10: Cross section of the 2.4 x 3.05 m wall test opening at the National Research Council. The rooms are constructed of 300 mm concrete and supported on steel springs. Walls for testing are usually mounted on the wheeled test frame, which is not in solid contact with the structure of the source or receiving rooms. In this case, one wythe of the cavity block wall was mounted on the frame, the other was mounted in the receiving room opening.

An additional advantage of the mounting technique shown in Fig. 10 is that, since the test frame is on wheels, it allows simple changes of the sound absorbing materials in the cavity.

Figures 11a and 11b show the results for this mounting. As expected, the STC rating is high in each case and there is no sign of reduction in transmission loss at the lower frequencies relative to the single wythe 190 mm or 90 mm block wall. It is interesting to see that, even in a heavy construction like this, there is still something to be gained by using effective sound absorbers in the cavity; styrofoam does not absorb sound well.

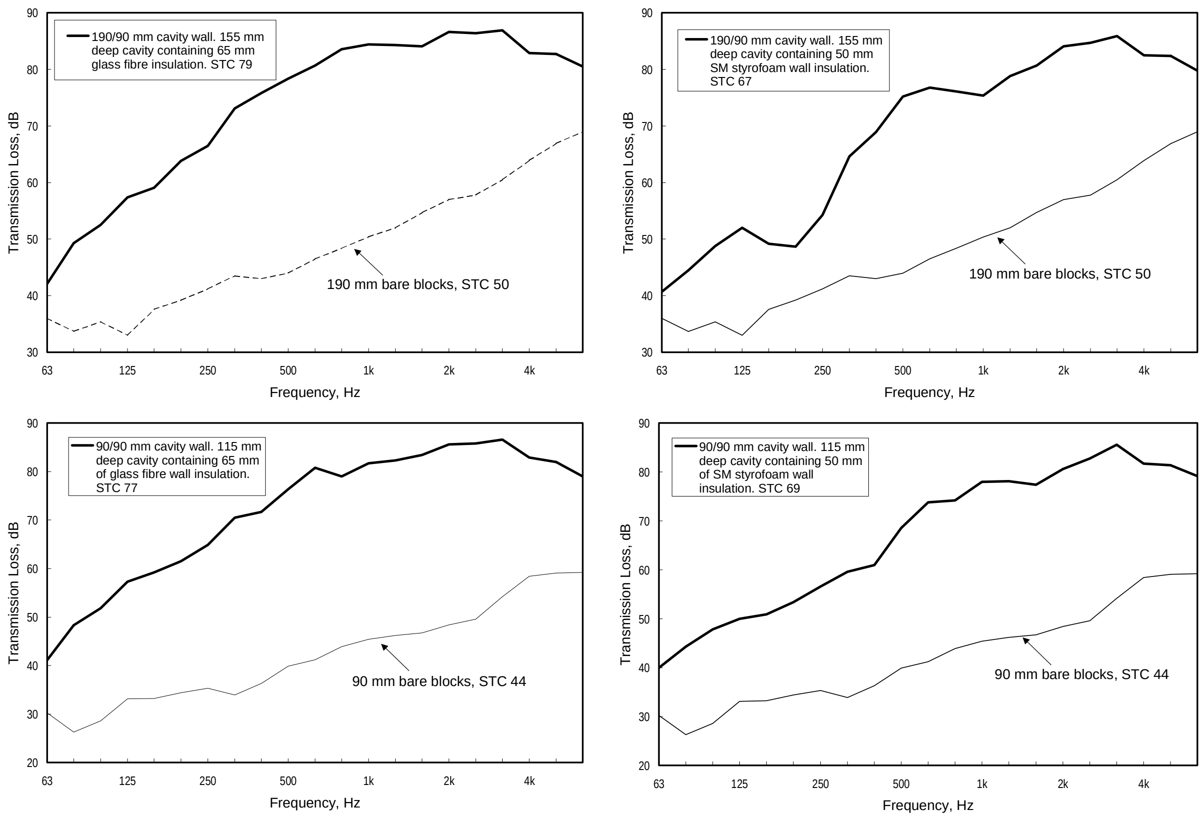

Figure 11: Sound transmission loss curves for cavity block walls mounted as shown in Figure 10. Results for single wythe block walls are shown in each graph.

Room/test frame mounting results - 90/90 mm blocks

The 190 mm block wall on the test frame was demolished and replaced with a 90 mm block wall. This allowed a further set of measurements to be made with the same set of materials in the cavity. The results are shown in Fig. 11c and 11d. Reductions in sound transmission loss due to the use of the lighter 90 mm block are slight.

Test frame only mounting - 90/90 mm blocks

The 90 mm split rib block was demolished and a nominally identical wall constructed on the frame as shown in Figure 12. In this configuration, there will be transmission of acoustical energy through the structure of the frame. This flanking transmission will be reduced to some extent because of the construction of the frame liner which is shown in the expanded section of Figure 12.

The measured sound transmission loss for this configuration is shown in Figure 13. There is a substantial decrease in performance relative to the case where the blocks are isolated.

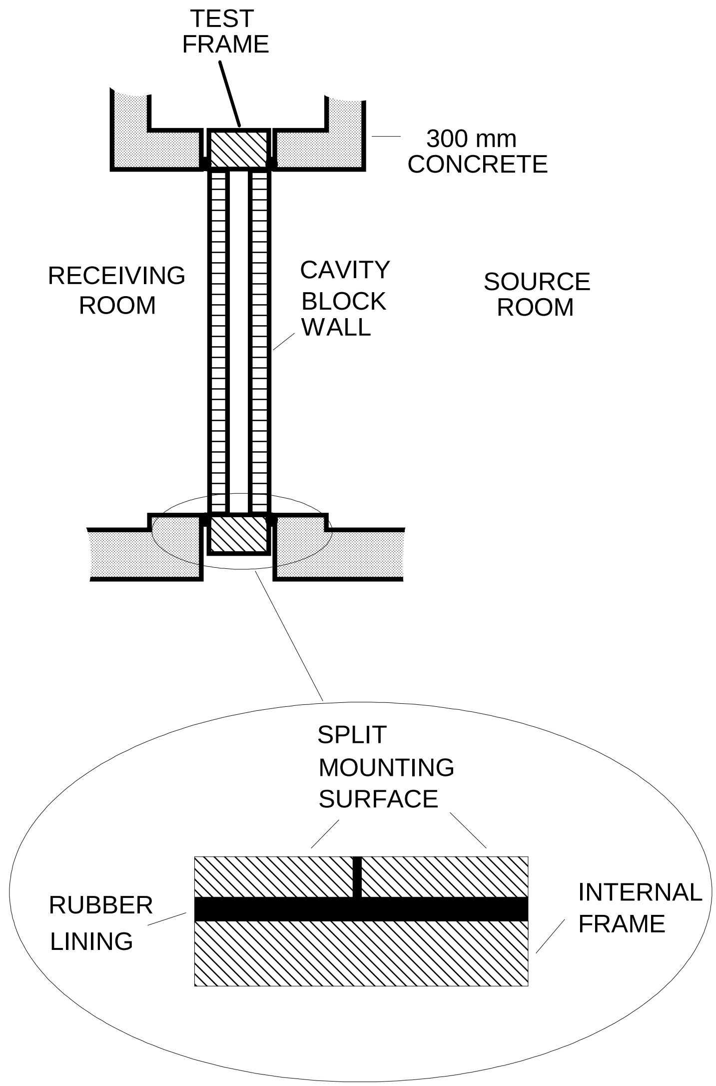

Figure 12: Cavity wall with both 90 mm wythes constructed on the test frame. Some flanking through the wood liner of the test frame is possible, although the rubber inserts will reduce this to some extent.

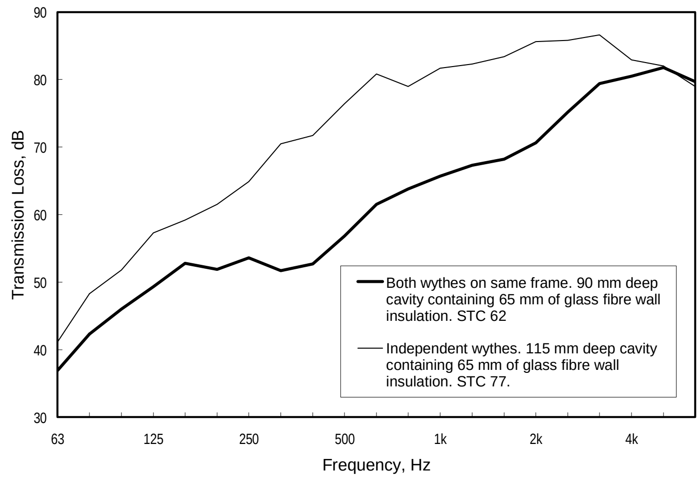

Figure 13: Transmission loss measurement for 90/90 mm cavity wall with both wythes mounted on the test frame. A result from Figure 11 is shown for comparison.

Conclusions for cavity walls

The basic principles governing the sound transmission loss through cavity walls still apply to cavity block walls. The measurements reported here make it clear that it is extremely difficult to give a definitive rating to the sound transmission loss for such walls. Even in the laboratory, where construction is carefully controlled, it is possible to get widely differing answers. The lesson to be drawn from this is that to merely approach the potential of a cavity wall requires extremely careful design to reduce flanking transmission and close supervision of construction to ensure that no errors are made.

Overall conclusions

The issue of block porosity and its effect on sound transmission loss of composite walls needs to be studied further. Measurements over the same frequency range need to be carried out in a similar systematic fashion using lightweight, more porous blocks.

To validate the prediction scheme presented here, it is desirable that measurements be made using more than one type of block. The number of systems measured could be reduced because of the knowledge gained from the present series.

The cavity walls tested here were not linked together with wire ties. It would be useful to establish through measurement what effect ties have and perhaps find a tie design that has minimum acoustical influence.

In future measurements on block walls, the air flow resistivity should be measured and presented as part of the sound transmission loss report

Table 2: Mean differences in transmission loss relative to the bare 190 mm block wall.

		Frequency, hertz																				
		63	**80**	**100**	**125**	**160**	**200**	**250**	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**	**2500**	**3150**	**4000**	**5000**	**6300**
WS38	Mean	-1.3	-4.4	-7.4	-1.7	-1.1	3.1	3.1	1.2	4.7	5.0	6.4	6.5	5.6	5.4	4.5	3.3	0.0	0.4	1.1	2.5	4.3
WS38	SD	1.0	0.9	0.4	0.6	0.9	1.2	1.1	1.0	0.5	0.2	0.3	0.2	0.5	0.5	0.4	0.9	0.6	0.5	0.4	0.5	0.3
WS38_GFB38	Mean	-3.4	-5.3	-5.5	2.3	5.7	9.7	8.5	5.7	7.8	6.3	5.9	5.9	5.7	6.4	6.0	3.5	0.1	1.1	2.2	3.5	4.7
WS38_GFB38	SD	0.8	0.8	1.7	1.0	1.3	1.2	1.7	2.0	1.7	1.0	0.5	0.8	0.9	1.4	1.9	1.3	0.9	1.1	1.4	0.9	1.2
RC13	Mean	-0.2	-0.3	-2.3	-1.6	-3.6	-4.0	-3.6	-0.2	4.5	6.6	6.2	6.8	5.8	6.2	5.7	4.6	3.9	3.4	3.4	3.9	3.4
RC13	SD	0.2	0.7	0.2	0.4	0.1	0.2	0.1	0.6	0.6	0.8	1.6	2.3	3.1	3.2	2.8	2.3	1.8	2.0	1.6	0.9	0.8
RC13_GFB19	Mean	-2.3	-3.6	-5.8	-3.5	-1.1	2.5	5.8	7.6	9.0	8.9	7.8	8.0	7.8	7.7	6.5	5.1	5.2	4.7	4.7	4.7	3.6
RC13_GFB19	SD	1.4	0.5	1.4	1.4	1.3	0.7	0.4	0.8	1.7	2.6	2.9	3.2	3.7	3.6	3.4	2.8	2.6	2.8	2.1	2.1	2.4
ZC50	Mean	-3.7	-5.1	-6.8	-3.3	-1.9	-1.0	1.6	4.1	7.6	9.3	9.2	9.6	10.0	9.9	8.6	6.6	4.3	3.4	3.8	4.2	2.7
ZC50	SD	0.4	0.6	2.7	1.3	1.8	1.5	3.0	1.4	0.6	0.7	1.0	1.5	1.8	0.8	0.8	1.1	0.5	0.9	1.3	1.4	1.4
ZC50_GFB50	Mean	-5.1	-5.5	-2.3	4.2	5.5	7.7	8.4	10.2	12.5	12.2	11.9	11.7	10.3	9.5	6.5	5.1	4.5	4.2	4.6	4.5	2.5
ZC50_GFB50	SD	1.1	0.4	2.7	0.5	1.7	1.4	3.2	2.1	1.9	2.2	2.7	3.0	3.4	3.2	3.1	2.3	1.6	1.7	1.9	2.1	2.5
SS65	Mean	-4.7	-3.8	-3.0	1.0	2.5	6.4	8.8	10.0	14.6	16.6	15.5	15.1	13.3	10.7	8.6	7.7	7.0	7.3	7.6	7.1	4.2
SS65	SD	1.6	1.1	2.2	0.9	2.1	1.7	2.9	2.6	1.1	1.3	1.1	1.5	1.9	2.2	1.3	0.7	0.5	0.6	1.1	2.1	2.5
SS65_GFB65	Mean	-4.0	-0.8	2.5	7.1	8.3	11.8	13.7	14.3	15.4	14.8	13.9	13.1	11.0	9.0	8.2	7.8	7.7	9.0	8.4	7.2	4.7
SS65_GFB65	SD	1.2	0.5	2.8	2.0	2.7	2.8	3.4	2.4	1.8	2.5	2.8	2.9	3.2	2.3	1.1	1.0	1.4	1.0	1.6	1.8	2.2
ZC75	Mean	-5.7	-6.2	-1.6	1.9	3.8	4.4	7.8	10.5	12.9	14.2	14.4	13.3	11.5	10.9	10.0	6.3	3.7	4.4	6.6	6.3	5.5
ZC75	SD	0.7	0.3	3.5	2.2	2.9	2.9	4.3	3.1	1.6	2.3	2.8	2.7	2.5	0.4	0.9	0.3	1.0	0.8	1.0	0.6	1.4
ZC75_GFB75	Mean	-5.2	-2.1	4.2	8.1	10.6	12.3	12.9	12.5	16.0	16.1	15.1	13.4	11.2	10.3	10.0	8.4	5.3	6.2	7.4	6.1	4.2
ZC75_GFB75	SD	1.7	1.3	3.0	1.8	2.9	3.0	3.3	2.2	1.5	2.7	3.0	3.1	3.1	1.9	1.6	1.2	1.4	1.1	1.8	2.1	2.9

Table 3: STC ratings predicted for block walls using TL-88-447, 90 mm normal weight blocks. Table headings are methods of attaching 16 mm drywall

		Bare	B	C	D	E	F	G	H	I	J	K
	Bare	44										
B	WS38	48	50									
C	WS38_GFB38	50	53	54								
D	RC13	47	49	53	45							
E	RC13_GFB19	50	51	55	49	49						
F	ZC50	50	50	55	48	49	49					
G	ZC50_GFB50	53	56	58	55	57	57	60				
H	SS65	54	55	59	52	53	54	61	58			
I	SS65_GFB65	56	58	60	58	59	60	63	64	65		
J	ZC75	54	55	58	53	54	54	60	59	63	59	
K	ZC75_GFB75	56	58	60	58	61	60	63	64	65	63	65

Table 4: STC ratings predicted for block walls using BRN217-6NA, 140 mm blocks. Table headings are methods of attaching 16 mm drywall

		Bare	B	C	D	E	F	G	H	I	J	K
	Bare	45										
B	WS38	48	49									
C	WS38_GFB38	52	54	56								
D	RC13	46	47	53	42							
E	RC13_GFB19	50	49	53	47	47						
F	ZC50	49	49	53	45	47	47					
G	ZC50_GFB50	54	56	60	53	55	55	62				
H	SS65	54	53	57	50	52	52	59	56			
I	SS65_GFB65	57	59	63	56	58	58	65	62	68		
J	ZC75	54	54	58	50	52	53	60	57	63	58	
K	ZC75_GFB75	58	60	63	58	59	59	65	63	68	64	68

Table 5: STC ratings predicted for block walls using TL88-473, 75% solid, 140 mm blocks. Table headings are methods of attaching 16 mm drywall

		Bare	B	C	D	E	F	G	H	I	J	K
	Bare	47										
B	WS38	51	53									
C	WS38_GFB38	54	57	60								
D	RC13	46	49	54	42							
E	RC13_GFB19	53	56	60	52	54						
F	ZC50	51	53	58	47	54	52					
G	ZC50_GFB50	58	60	64	54	61	59	66				
H	SS65	58	59	64	55	58	58	66	63			
I	SS65_GFB65	60	64	66	60	64	64	69	69	72		
J	ZC75	57	59	63	54	59	57	65	64	69	62	
K	ZC75_GFB75	61	64	66	59	65	64	69	69	72	69	72

Table 6: STC ratings predicted for block walls using TL88-487, 100% solid 140 mm blocks. Table headings are methods of attaching 16 mm drywall

		Bare	B	C	D	E	F	G	H	I	J	K
	Bare	50										
B	WS38	53	55									
C	WS38_GFB38	57	60	63								
D	RC13	48	51	57	44							
E	RC13_GFB19	55	55	61	52	55						
F	ZC50	52	54	60	48	54	51					
G	ZC50_GFB50	60	62	66	56	62	60	68				
H	SS65	59	59	65	56	59	58	65	62			
I	SS65_GFB65	63	64	69	61	64	64	71	68	74		
J	ZC75	58	60	65	54	60	57	65	64	69	62	
K	ZC75_GFB75	63	66	69	61	67	65	71	70	74	70	74

Table 7: STC ratings predicted for block walls using TL-88-356 190 mm blocks. Table headings are methods of attaching 16 mm drywall.

		Bare	B	C	D	E	F	G	H	I	J	K
	Bare	50										
B	WS38	53	54									
C	WS38_GFB38	55	58	60								
D	RC13	51	53	58	49							
E	RC13_GFB19	53	52	56	52	50						
F	ZC50	54	52	56	52	50	50					
G	ZC50_GFB50	59	59	63	60	58	58	65				
H	SS65	58	56	60	56	55	55	62	59			
I	SS65_GFB65	61	62	66	63	61	61	68	65	71		
J	ZC75	59	57	61	57	55	56	63	60	66	61	
K	ZC75_GFB75	62	63	67	64	62	62	69	66	72	67	72

Table 8: STC ratings predicted for blocks walls using BRN217-10NA 240 mm normal weight blocks. Table headings are methods of attaching 16 mm drywall

		Bare	B	C	D	E	F	G	H	I	J	K
	Bare	48										
B	WS38	50	50									
C	WS38_GFB38	54	57	59								
D	RC13	48	48	54	44							
E	RC13_GFB19	51	50	55	48	49						
F	ZC50	50	49	55	47	49	48					
G	ZC50_GFB50	57	57	62	54	57	56	63				
H	SS65	55	54	60	51	54	53	60	57			
I	SS65_GFB65	60	59	66	57	59	59	66	63	69		
J	ZC75	56	55	61	52	55	54	62	58	64	60	
K	ZC75_GFB75	60	62	66	59	61	61	67	65	71	66	71

Table 9: STC ratings predicted for block walls using BRN217-12NA 290 mm normal weight blocks. Table headings are methods of attaching 16 mm drywall.

		Bare	B	C	D	E	F	G	H	I	J	K
	Bare	49										
B	WS38	53	52									
C	WS38_GFB38	56	56	60								
D	RC13	51	52	56	48							
E	RC13_GFB19	52	50	54	50	48						
F	ZC50	52	50	54	50	48	49					
G	ZC50_GFB50	59	58	62	58	56	56	64				
H	SS65	56	55	59	55	53	53	61	57			
I	SS65_GFB65	61	61	65	61	59	59	67	63	70		
J	ZC75	57	55	60	56	54	54	61	58	64	59	
K	ZC75_GFB75	62	62	66	62	60	60	68	64	71	65	72

Appendix A1

To avoid needless repetition descriptions of the materials and the construction techniques used in this work are collected in this Appendix.

CONCRETE BLOCKS

Concrete blocks were laid-up in a running bond pattern using a Type-N mortar mix and the mortar joints tooled to a concave finish. The walls were reinforced horizontally by embedding a Dur-O-Wal DW100 Standard Class Wire Truss in the mortar joint on every second course of blocks. The width of the wire truss varied with the width of the concrete block. Single wythe wire trusses were used on the cavity wall system. Corrugated wall ties were also used on every second course embedded in the mortar and secured to the wood frame of the mounting rack with nails.

1. Block Information

A - 90 mm Normal weight Concrete block

190 mm high x 390 mm long x 90 mm deep
Weight / Block = 10.9 kg
Weight / unit area = 147.3 kg/m^2

B - 90 mm Split-Rib Concrete Block (Six Ribs)

190 mm high x 390 mm long x 90 mm deep
Weight / Block = 13.44 kg
Weight / unit area = 181.4 kg/m^2

C- 140 mm 75% Solid Concrete Block

190 mm high x 390 mm long x 140 mm deep
Weight / Block = 17.84 kg
Weight / unit area = 240.1 kg/m^2

D - 140 mm 100% Solid Concrete Block

190 mm high x 390 mm long x 140 mm deep
Weight / Block = 22.28 kg
Weight / unit area = 300.7 kg/m^2

E - 190 mm Normal weight Concrete Block

190 mm high x 390 mm long x 190 mm deep
Weight / Block = 17.5 kg
Weight / unit area = 236.2 kg/m^2

2. USG Z-FURRING CHANNELS, 50 and 75 mm

The channels are formed from 0.50 mm thick galvanized sheet metal. They were applied horizontally on 600 mm centres with the small flange of the channel secured to the block wall surface with 19 mm long Tapcon screws on 600 mm centres.

50 mm Z-Bars
Flange #1, 20 mm wide, Flange #2, 30 mm wide, 50 mm deep. Weight = 0.34 kg/m.

75 mm Z-Bars
Flange #1, 25 mm wide, Flange #2, 35 mm wide, 75 mm deep. Weight = 0.52 kg/m.

3. RESILIENT METAL FURRING CHANNELS

The channels were applied horizontally on 600 mm centres with the wall mounting flange downward, and secured to the block wall surface with 19 mm long Tapcon screws on 600 mm centres. The channels were 13 mm deep and formed from galvanized sheet metal 0.50 mm thick. They weighed 0.26 kg/m.

4. 65 mm NON-LOAD BEARING STEEL STUDS

The studs were placed vertically on 600 mm centres and held in place by upper and lower metal tracks. These were positioned as close as possible to the block surface and secured to the wood frame of the wall mounting rack with 25 mm long wood screws. Caulking compound was applied to the backs of the upper and lower tracks and both end studs before securing them in position. The studs weighed 0.46 kg/m.

5. WOOD FURRING STRIPS

40 mm square wood furring strips (pine) were applied horizontally on 600 mm centres and secured to the block wall surface with 70 mm long Tapcon screws on 600 mm centres. The furring weighed 0.65 kg/m.

6. CAVITY WALL INSULATION

A - SM Styrofoam Insulation (Blue Extruded Styrene Foam)

The panels were 610 mm wide x 2.44 m long x 50 mm thick. The edges were rabbeted to form an overlap joint. The weight/unit area was 1.47 kg/m^2. The panels were applied vertically with overlapped edge joints and secured to the block wall surface with random dabs of insulation adhesive.

B - Fiberglas Canada Cavity Wall Insulation Panels.

These were rigid Fiberglas panels faced on one side with a thin layer of bituminous material covered with a Kraft paper. Total thickness of the facing layer was 1 mm. The panels were 400 mm wide x 1.22 m long x 65 mm thick. Panels were positioned with the treated surface in contact with the block wall surface and secured with random dabs of insulation adhesive. Weight/unit area was 4.13 kg/m^2.

7. GLASS FIBRE CAVITY ABSORPTION

(Fiberglas Canada Materials)

AF300:	19 mm thick, weight/unit area = 0.4 kg/m^2
AF300:	38 mm thick, weight/unit area = 0.7 kg/m^2
R8:	65 mm thick, weight/unit area = 0.83 kg/m^2
R12:	90 mm thick, weight/unit area = 1.16 kg/m^2

8. GYPSUM WALLBOARD

Direct Application: Gypsum wallboard was applied horizontally in 1.22 m wide x 3.05 m long sheets and secured to the block wall surface with 45 mm screws spaced between 200 mm and 250 mm at the edges and between 350 mm and 400 mm in the field.

Attachment to wall support systems: Gypsum wallboard was applied horizontally in 1.22 m wide x 3.05 m long sheets and secured to all metal support systems using 25 mm long drywall screws and to the wood furring with 32 mm long drywall screws. All screws were spaced between 200 mm and 250 mm centres at the edges and between 350 mm and 400 mm in the field. The 13 mm wallboard weighed 9.2 kg/m^2. The 16 mm wallboard weighed 10.7 kg/m^2.

9. PERIMETER AND JOINT SEALS

Concrete Block Wall: After the wall was cured, a bead of caulking compound was applied around the perimeter on both sides of the wall to seal any possible shrinkage cracks between the mortar joint and the wood frame of the wall mounting rack.

Gypsum Wallboard: The perimeter joint between the gypsum wallboard and the wood frame of the mounting rack was sealed with a 25 mm wide x 3 mm thick glazing and an aluminum foil adhesive tape. The horizontal joint between the sheets of gypsum wallboard was sealed with a double layer of aluminum foil adhesive tape.

10 - LATEX PAINT BLOCK SEALER

Two coats of CIL Super Latex Undercoat Primer were applied the wall surface using a brush and deep pile paint roller. The first coat was allowed to dry for at least 4 hours before applying the second coat.

Appendix A2

The table on the following pages contains the transmission loss data for all walls tht were measured during this series. To condense the information, a codified system for describing the walls is used. The abbreviations for the materials used are as follows.

BLK	concrete block
G	gypsum drywall
WFUR	wood furring
RC	resilient metal channels
ZC	Z-bars
SS	non-load-bearing steel studs
GFB	glass fibre batts
GFRP	glass fibre cavity wall insulation (semi-rigid panels)
AIR	air
PAI	paint
STY	styrofoam insulation

If a number follows the abbreviation, it gives the thickness of the material in mm. Descriptions are generated by mentally travelling through the wall from one side to the other describing each material encountered on the way. Underscores act as separators for each layer. Thus the coded description

G16_RC13_GFB19_BLK190_SS65_GFB65_G16_G16

would be read as

16 mm drywall mounted on 13 mm resilient metal channels applied to one side of a 190 mm block wall with 19 mm of glass fibre batt compressed behind the drywall. On the second side, two layers of 16 mm drywall were supported on 65 mm steel studs. There were 65 mm thick glass fibre batts in the cavity.

This wall was not actually tested in the series and is only used to illustrate the coding.

Table 10: Complete list of TL data for all configurations tested.

TestID	STC	Description	63	80	100	125	160	200	250	315
TL-88-356	50	BLK190	36.0	33.7	35.4	33.0	37.6	39.2	41.2	43.5
TL-88-357	55	BLK190_WFUR40_GFB38_G16	31.6	29.0	28.6	36.7	42.2	48.5	48.2	47.1
TL-88-358	59	G16_GFB38_WFUR40_BLK190_WFUR40_GFB38_G16	31.9	23.2	22.6	38.0	45.7	55.3	54.3	49.6
TL-88-360	58	G16_GFB38_WFUR40_BLK190_WFUR40_G16	31.6	23.9	21.2	34.3	42.5	53.4	52.9	49.4
TL-88-361	54	G16_WFUR40_BLK190_WFUR40_G16	32.6	25.4	20.6	30.0	34.5	44.1	46.2	45.2
TL-88-362	53	G16_WFUR40_BLK190	35.3	30.7	27.4	32.1	35.4	42.3	43.0	43.2
TL-88-366	57	G16_GFB38_WFUR40_BLK190_G16	32.9	28.1	28.7	35.9	40.8	46.6	46.4	49.1
TL-88-367	58	G16_GFB38_WFUR40_BLK190_RC13_G16	32.0	27.5	27.5	34.0	39.1	44.3	45.5	49.8
TL-88-368	51	BLK190_RC13_G16	35.7	32.4	33.4	31.4	33.9	35.4	37.7	42.5
TL-88-371	54	BLK190_RC13_GFB19_G16	34.3	30.1	29.2	30.5	36.1	41.7	47.1	52.3
TL-88-372	49	G16_GFB19_RC13_BLK190_RC13_GFB19_G16	32.9	27.1	22.2	24.9	33.9	43.4	52.4	59.2
TL-88-373	52	G16_GFB19_RC13_BLK190_RC13_G16	34.4	30.7	26.8	28.2	32.5	37.9	43.4	52.4
TL-88-374	49	G16_RC13_BLK190_RC13_G16	35.3	32.5	31.0	30.3	30.4	31.2	34.2	43.0
TL-88-379	59	G16_RC13_GFB19_BLK190_ZC50_G50_G16	28.3	25.1	26.2	35.0	41.5	48.9	52.9	59.9
TL-88-381	59	G16_GFB50_ZC50_BLK190	32.5	28.9	29.6	36.7	40.7	45.2	46.7	53.3
TL-88-384	64	G16_GFB50_ZC50_BLK190_ZC50_GFB50_G16	24.9	22.3	31.7	40.0	48.9	55.0	58.4	63.3
TL-88-385	59	G16_ZC50_BLK190_ZC50_GFB50_G16	28.2	22.9	26.1	34.8	40.9	46.0	52.7	59.6
TL-88-386	52	G16_ZC50_BLK190_ZC50_G16	28.6	23.3	21.0	27.6	32.4	35.4	41.2	50.8
TL-88-387	52	BLK190_ZC50_G16	32.8	28.6	24.4	29.8	33.1	36.2	39.1	46.0
TL-88-389	52	G16_BLK190_ZC50_G16	32.5	28.6	25.3	30.0	32.9	35.7	37.6	45.0
TL-88-390	50	BLK190_G16	36.0	32.8	30.9	35.4	33.5	35.5	35.3	41.0
TL-88-391	49	G16_BLK190_G16	34.7	33.5	30.9	35.7	33.4	34.5	34.4	39.6
TL-88-392	61	G16_BLK190_SS65_GFB65_G16	30.7	32.6	32.6	39.6	40.3	45.8	48.0	54.3
TL-88-393	60	BLK190_SS65_GFB65_G16	30.3	32.2	32.0	39.1	40.5	46.7	48.6	54.9
TL-88-397	72	G16_GFB65_SS65_BLK190_SS65_GFB65_G16	27.3	30.7	40.0	49.4	54.0	61.6	66.9	72.7
TL-88-398	65	G16_SS65_BLK190_SS65_GFB65_G16	27.3	28.5	32.1	40.7	46.6	54.8	60.6	69.0
TL-88-403	57	G16_SS65_BLK190_SS65_G16	23.5	24.4	25.2	33.0	39.6	48.4	50.7	60.5
TL-88-406	58	BLK190_SS65_G16	29.3	29.0	29.3	35.6	37.1	43.4	47.0	53.2
TL-88-407	66	G16_GFB75_ZC75_BLK190_SS65_G16	26.7	28.8	32.8	41.7	47.1	55.9	59.8	66.1
TL-88-413	73	G16_GFB75_ZC75_BLK190_SS65_GFB65_G16	26.1	29.3	40.6	50.3	55.8	63.5	66.2	68.1
TL-88-416	68	G16_ZC75_BLK190_SS65_GFB65_G16	25.7	26.6	35.2	44.2	48.3	54.6	62.3	69.5
TL-88-417	59	G16_ZC75_BLK190_SS65_G16	24.9	23.2	28.1	35.0	41.3	47.7	55.4	61.9
TL-88-418	57	G16_ZC75_BLK190	29.7	27.1	29.6	34.3	37.9	40.1	44.0	50.9
TL-88-419	57	G16_ZC75_BLK190_G16	29.9	27.0	29.3	35.0	37.3	39.8	42.5	50.3
TL-88-420	62	G16_ZC75_GFB75_BLK190_G16	29.4	31.3	35.6	42.0	44.0	47.3	49.2	56.2
TL-88-421	61	G16_ZC75_GFB75_BLK190	29.0	30.5	35.2	41.5	44.4	47.7	49.1	55.7
TL-88-422	60	G16_ZC75_GFB75_BLK190_PAI	30.4	33.8	35.8	37.5	44.5	47.5	49.6	55.3
TL-88-423	58	G16_ZC75_BLK190_PAI	29.8	29.2	29.6	33.7	37.9	40.5	46.2	52.4
TL-88-424	48	BLK190_PAI	35.4	35.3	32.2	32.6	34.6	35.8	37.0	41.5
TL-88-426	50	G16_BLK190_PAI	35.2	34.7	31.2	34.3	34.0	34.7	36.1	41.4
TL-88-427	46	G16_BLK190_PAI_G16	36.2	34.1	30.8	33.6	31.7	31.7	31.8	35.5

TestID	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300
TL-88-356	43.0	44.0	46.5	48.4	50.4	52.0	54.7	57.0	57.8	60.5	63.9	66.9	69.0
TL-88-357	49.4	49.5	51.9	54.6	57.0	59.9	61.9	60.6	57.7	61.1	65.6	70.3	73.8
TL-88-358	54.1	54.5	57.4	62.4	63.2	65.6	65.6	63.0	57.1	61.2	66.5	71.7	76.5
TL-88-360	54.7	54.8	58.7	60.9	61.8	64.5	65.8	63.9	57.4	61.4	66.4	72.4	77.6
TL-88-361	51.9	53.8	58.9	61.6	62.1	63.3	64.2	63.7	57.9	61.4	66.2	72.1	77.8
TL-88-362	46.9	49.0	52.9	54.7	55.9	57.7	59.1	59.1	57.0	60.2	64.6	68.9	73.2
TL-88-366	53.2	54.1	56.9	58.8	60.5	62.8	64.8	62.7	57.7	61.7	66.7	71.5	75.8
TL-88-367	55.9	58.1	60.3	62.7	64.8	66.4	66.7	66.0	62.8	66.2	70.2	74.2	77.0
TL-88-368	46.6	50.7	54.3	58.1	60.6	62.7	64.2	64.8	63.9	66.2	68.8	71.2	73.2
TL-88-371	54.6	56.8	58.7	61.2	63.6	65.1	66.4	66.3	66.7	69.2	71.8	74.6	75.9
TL-88-372	61.9	62.4	63.1	65.1	66.5	68.5	69.3	68.3	68.2	69.9	73.9	78.0	78.2
TL-88-373	59.2	62.1	62.2	64.8	65.5	67.4	68.6	68.0	67.9	69.5	72.6	76.9	78.1
TL-88-374	52.0	58.1	60.8	64.1	64.7	66.9	68.3	68.0	67.5	69.4	72.3	75.8	76.7
TL-88-379	63.7	65.1	66.0	67.7	68.3	69.1	67.7	67.8	68.4	70.4	73.1	75.6	74.4
TL-88-381	56.3	57.4	59.6	61.0	61.1	63.2	63.8	64.5	63.4	65.8	69.6	73.4	73.8
TL-88-384	67.6	70.2	71.3	74.1	74.4	74.8	72.0	70.2	68.4	70.2	73.6	76.4	75.1
TL-88-385	64.8	67.5	70.1	72.3	73.6	73.7	71.3	69.5	67.3	68.6	72.8	76.2	75.0
TL-88-386	58.4	63.2	65.8	69.1	71.7	72.2	70.8	69.3	66.3	67.2	71.4	74.9	73.9
TL-88-387	50.1	53.5	55.5	57.6	59.7	62.3	64.2	64.7	61.8	63.2	66.4	70.3	71.2
TL-88-389	50.2	54.5	57.8	60.7	62.7	64.6	66.0	65.4	61.3	63.4	67.6	73.0	73.8
TL-88-390	43.1	46.4	50.1	53.3	55.1	56.1	56.8	57.9	56.1	58.5	61.7	66.5	68.9
TL-88-391	43.4	48.1	52.8	56.4	57.7	58.6	59.9	60.0	56.4	59.5	63.5	68.0	71.8
TL-88-392	58.3	59.5	62.1	64.3	64.1	64.1	64.6	64.6	64.1	68.5	72.4	75.5	76.3
TL-88-393	57.8	57.4	59.0	60.9	61.3	62.3	63.1	63.5	63.6	68.2	71.2	73.8	75.3
TL-88-397	73.1	74.8	74.4	75.6	73.5	72.6	72.6	73.3	71.6	77.3	79.9	81.2	79.0
TL-88-398	71.5	73.9	74.0	74.6	72.3	71.2	71.3	72.2	71.0	75.6	78.9	81.1	79.2
TL-88-403	68.9	73.3	74.0	74.7	73.9	73.3	73.4	73.5	70.6	73.3	75.7	75.1	73.7
TL-88-406	58.9	62.4	62.9	65.8	66.8	66.8	65.4	65.2	65.3	68.2	73.3	77.6	78.1
TL-88-407	72.2	74.3	74.6	75.7	74.8	74.0	74.1	73.3	68.9	72.1	78.2	80.8	78.5
TL-88-413	74.7	76.7	77.8	78.6	77.3	74.4	74.3	74.3	71.7	75.8	79.9	81.0	78.5
TL-88-416	72.4	74.3	76.1	77.1	76.0	73.8	73.0	70.8	69.4	73.5	78.1	81.2	79.6
TL-88-417	69.7	73.1	74.8	76.4	75.7	73.5	72.6	69.3	67.8	71.9	77.3	80.1	78.3
TL-88-418	54.1	56.0	58.4	60.5	61.6	63.5	64.6	62.9	60.3	63.8	69.3	72.4	74.9
TL-88-419	55.7	59.7	63.1	64.0	63.7	66.6	67.9	64.3	59.9	63.6	69.6	73.0	75.9
TL-88-420	60.7	63.5	64.7	64.8	63.6	66.5	68.6	66.5	62.2	66.1	71.3	74.7	76.4
TL-88-421	58.2	59.2	60.3	61.7	62.3	64.2	65.3	64.6	62.1	65.8	70.7	73.8	75.5
TL-88-422	58.5	59.6	60.4	61.3	62.1	64.1	65.1	64.4	62.2	65.6	70.7	73.7	76.0
TL-88-423	55.7	58.2	60.4	62.0	61.6	63.9	65.1	64.9	61.8	65.1	70.4	73.3	74.9
TL-88-424	42.0	44.1	45.6	47.0	48.3	50.1	53.3	56.0	56.2	58.8	62.7	65.7	67.7
TL-88-426	44.3	47.5	50.6	53.6	55.5	58.8	62.1	62.8	61.0	63.5	67.7	71.6	74.3
TL-88-427	38.7	44.2	50.0	55.9	59.6	63.0	65.5	65.5	63.4	64.7	68.4	73.9	76.5

			Frequency, Hz							
TestID	STC	Description	63	80	100	125	160	200	250	315
		190/90 mm cavity walls								
TL-88-431	79	BLK90_AIR100_GFRP65_BLK190_G16	42.1	49.3	52.5	57.4	59.1	63.8	66.5	73.1
TL-88-432	67	BLK90_AIR115_STY50_BLK190_G16	40.7	44.5	48.8	52.0	49.2	48.7	54.3	64.6
		90/90 mm cavity walls								
TL-88-436	73	BLK90_AIR60_GFB65_BLK90	39.7	46.5	50.5	53.8	53.7	57.1	61.7	66.8
TL-88-440	77	BLK90_AIR60_GFRP65_BLK90_G16	41.1	48.3	51.8	57.3	59.2	61.5	64.9	70.5
TL-88-441	69	BLK90_AIR125_BLK90_G16	39.6	45.1	50.8	52.4	51.6	53.5	57.3	60.1
TL-88-442	69	BLK90_AIR75_STY50_BLK90_G16	40.0	44.3	47.8	50.0	50.9	53.4	56.6	59.6
		9**0 mm split rib on chamber lip**								
TL-88-447	44	BLK90	32.3	30.5	30.3	31.9	32.4	34.5	36.9	37.7
		90/90 mm on test frame								
TL-88-459	62	BLK90_AIR25_GFRP65_BLK90_G16	36.9	42.3	46.0	49.3	52.8	51.9	53.6	51.7
		90 mm normal on frame								
TL-88-461	44	BLK90	30.2	28.3	29.1	33.1	33.4	34.7	36.2	36.9
		140 mm, 75% solid								
TL-88-473	47	BLK140	35.0	33.3	34.2	36.8	38.4	35.6	34.4	38.1
TL-88-474	61	G16_SS65_GFB65_BLK140	32.8	35.7	38.8	44.3	46.1	47.2	48.0	52.4
TL-88-475	67	G16_SS65_GFB65_BLK140_WFUR40_GFB38_G13	30.6	30.1	35.0	45.7	52.8	56.3	55.3	57.4
TL-88-476	55	BLK140_WFUR40_GFB38_G13	31.8	27.5	30.5	38.1	44.5	45.0	42.2	45.1
TL-88-477	56	PAI_BLK140_WFUR40_GFB38_G13	33.5	28.6	30.2	37.5	43.9	44.9	41.5	46.2
TL-88-478	48	PAI_BLK140	37.2	34.5	36.3	37.7	39.1	36.0	33.8	37.5
		140 mm, 100% solid								
TL-88-487	50	BLK140	38.0	31.8	34.7	38.2	36.3	35.3	36.6	40.8
TL-88-488	50	PAI_BLK140	38.8	34.4	34.2	37.4	34.4	33.6	37.3	41.6
TL-88-489	58	PAI_BLK140_GFB38_WFUR40_G13	34.3	29.5	28.4	37.9	44.3	43.7	43.6	47.6

	Frequency, Hz												
TestID	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000	6300
	190/90 mm cavity walls												
TL-88-431	75.8	78.4	80.7	83.6	84.4	84.3	84.1	86.6	86.4	86.9	82.9	82.7	80.5
TL-88-432	68.9	75.2	76.8	76.1	75.4	78.8	80.7	84.1	84.7	85.9	82.5	82.4	79.8
	90/90 mm cavity walls												
TL-88-436	70.9	74.9	77.3	74.2	75.8	75.8	74.7	80.9	83.1	84.8	82.5	81.7	78.90
TL-88-440	71.7	76.4	80.8	79.0	81.7	82.3	83.4	85.6	85.8	86.6	82.9	82.0	79.0
TL-88-441	61.6	70.4	76.0	75.2	77.8	77.2	78.4	83.4	83.5	84.7	82.0	81.2	79.0
TL-88-442	61.0	68.6	73.8	74.2	78.0	78.1	77.4	80.6	82.8	85.6	81.7	81.4	79.2
	9**0 mm split rib on chamber lip**												
TL-88-447	39.0	39.3	40.5	42.3	43.5	45.0	46.8	49.3	50.4	51.5	54.9	58.3	59.9
	90/90 mm on test frame												
TL-88-459	52.7	56.8	61.5	63.8	65.7	67.3	68.2	70.6	75.2	79.4	80.5	81.8	79.7
	90 mm normal on frame												
TL-88-461	36.9	39.5	40.8	43.5	44.6	45.9	46.4	48.3	49.3	53.4	57.1	58.0	58.2
	140 mm, 75% solid												
TL-88-473	40.3	42.4	45.2	48.2	51.2	53.5	54.8	57.3	60.6	63.1	64.4	68.8	72.6
TL-88-474	56.4	58.0	60.3	62.7	64.7	66.2	65.7	67.2	69.2	73.0	76.2	80.1	81.0
TL-88-475	62.4	63.0	65.2	67.7	70.6	71.6	72.8	72.5	72.9	73.7	77.6	81.2	81.9
TL-88-476	48.8	50.5	53.2	56.5	60.0	62.7	64.4	65.6	66.2	64.0	67.4	73.8	78.6
TL-88-477	49.5	50.9	53.9	56.8	59.2	62.2	64.1	65.7	66.4	63.8	67.2	73.9	78.8
TL-88-478	40.4	43.0	46.0	48.6	51.8	53.9	55.4	58.4	62.1	64.2	65.0	68.8	72.6
	140 mm, 100% solid												
TL-88-487	44.9	46.1	49.4	52.7	54.8	57.0	59.6	61.5	63.9	66.0	68.6	71.6	73.6
TL-88-488	44.5	46.3	50.1	52.8	55.5	57.7	60.2	61.8	64.1	66.2	68.4	71.0	72.6
TL-88-489	52.0	53.6	58.2	59.9	62.6	65.0	66.9	67.9	68.5	66.7	69.4	74.4	76.4