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SOMMAIRE

On décrit l'augmentation de la transmission sonore à travers plusieurs panneaux muraux suite à l'interaction avec le support dont l'effet sonore est réduit par un matériau d'amortissement.

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INFLUENCE OF SPECIMEN FRAME ON SOUND TRANSMISSION LOSS MEASUREMENT

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SUMMARY

Increased sound transmission through several wall specimens as a result of interaction with the specimen mounting frame is described. The effect of the frame is reduced by shielding it from the sound fields.

INTRODUCTION

There are many laboratories throughout the world engaged in making measurements of sound transmission loss through building partitions. Different countries have different standards that describe the test techniques and differ perhaps in language and some details but not in essential method. Perhaps the two best known standards are ISO 140[1] and ASTM standard E90[2]. Both documents include comments and recommendations on the subject of flanking transmission. In ISO 140, Part I, both the Introduction and the Scope state that the standard applies to laboratories where radiation from flanking elements has been suppressed. Later in Part I the same requirement is paraphrased, 'the sound transmitted by any indirect path should be negligible compared with the sound transmitted through the test specimen'. ASTM E90 requires (in its section on flanking transmission) that 'test rooms shall be so constructed and arranged that the test specimen constitutes the only important sound transmission path between them. The sound power transmitted through the test structure shall be at least 10 dB greater than the power transmitted into the receiving room by all other paths.'

The ASTM document has much more to say on this topic than does the ISO standard; in fact, it goes so far as to outline a series of measurements to determine whether some flanking path is seriously contaminating the measurements. While the language used in both standards is sufficiently general to cover all possible

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situations, there is, nevertheless, a suggestion that a flanking path is likely to be some alternative transmission path not directly associated with the specimen under test, for example, the walls of the room. The measurements described here show that for some types of laboratory a form of flanking can occur that varies in magnitude with the specimen being tested. This enhanced transmission is the result of vibration in the structure of the frame holding the specimens and the interaction between frame and specimen.

EXPERIMENTAL PROCEDURE

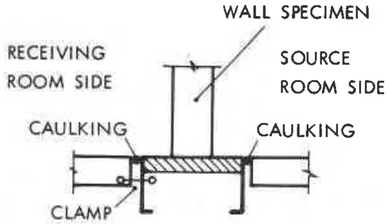
The measurements to be described were all performed in the reverberation room suite at the Division of Building Research, National Research Council of Canada. The room normally used as the source room has a volume of 65 m^3 and the receiving room a volume of 255 m^3 The opening for the test specimen measures $2{\cdot}44 \times 3{\cdot}05$ m. Both rooms are basically rectangular, spring-mounted and are equipped with fixed and rotating diffusers. Each contains nine electret condenser microphones to sample the sound fields and loudspeakers to generate sound.

Partitions to be tested are constructed in a wheeled steel frame that just fits between the two rooms. Once in place, the frame may be caulked around the periphery so that there is no solid contact between the frame and the rooms, or it can be clamped firmly to the receiving room and all residual gaps thoroughly caulked. In all but one of the measurements to be presented, the second procedure was used. The frame is 400 mm wide and is constructed from a U-channel of 9 mm steel. The inner surface of the steel is covered by a solid wood liner with a thickness of 105 mm to facilitate specimen mounting. The estimated weight of the frame is approximately 850 kg, excluding the specimen.

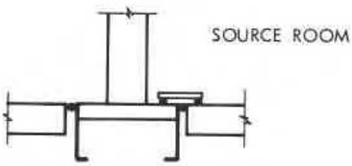
The measurement of sound pressure level and decay rate and analysis of the data are entirely computer controlled. The test procedure is in accordance with the requirements of both ISO 140 and ASTM E90. A complete Table of the measurements, including measured confidence limits, is printed and a plot of the results is the final computer output. The repeatability of computer-controlled measurements such as these is very easy to measure. In this case it is less than a few tenths of a decibel for all the frequencies of interest here, much less than the magnitudes of the observed differences.

EFFECT OF SPECIMEN POSITION

The first experiments to be described were performed some years ago with the intention of discovering the effects of moving the test specimen from the mid-plane of the frame to one edge. These data were extracted from internal laboratory

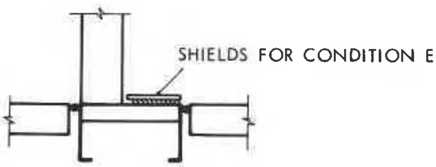


(A) NO SHIELDS, WALL IN MID-PLANE OF FRAME
- CONDITION A



(B) 12 mm GYPSUM SHIELDS RESTING ON FOAM STRIPS AND TAPED IN PLACE - CONDITION B

(C) AS FOR (B) BUT SHIELDS ON RECEIVING ROOM SIDE
- CONDITION C



(D) WALL MOVED TO RECEIVING ROOM EDGE OF FRAME, NO SHIELDS - CONDITION D

(E) AS FOR (D) BUT EXPOSED FRAME IN SOURCE ROOM SHIELDED WITH 12 mm GYPSUM RESTING ON 12 mm DENSE GLASS FIBRE AND SEALED WITH TAPE
- CONDITION E

Fig. 1. Frame shielding conditions studied.

records. The wall (No. 1) used during these investigations comprised 65 mm steel studs spaced 610 mm between centres, with 50 mm of low density glass fibre in the stud space. A layer of 13 mm gypsum wallboard was screw applied to each side of the studs. The joints between sections of the wall were sealed using caulking compound and fabric tape to simplify dismantling and reconstruction. Four conditions of this wall in the frame, designated A to D, were investigated and the details are shown in Fig. 1. The measured transmission losses for each case are shown in Fig. 2. These data were obtained without benefit of a computer analysis system, but nine microphones were still in use in each room so that the repeatability and precision of the measurements are good enough to allow one to say that the observed differences are real.

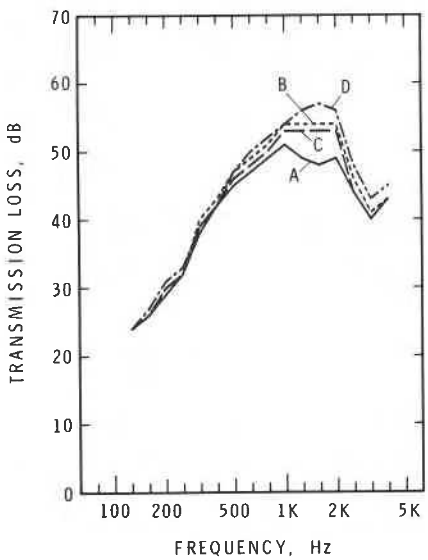


Fig. 2. Measured transmission for shielding conditions A, B, C, D, Wall No. 1.

When the specimen is at the receiving room edge of the frame (condition D), it might be assumed that flanking transmission through the frame has been eliminated since the frame is not exposed to the receiving room. Recent measurements show that this is not the case. Wall No. 2 comprised 92 mm steel studs spaced 610 mm between centres with 73 mm of low density glass fibre in the cavity. The receiving room side consisted of two layers of 13 mm gypsum board and the source room side consisted of three layers of 13 mm gypsum board. The wall was placed at the receiving room edge of the frame, as in condition D, but in this case the exposed frame in the source room was shielded, as in the earlier experiments, except that a

25 mm layer of high density, semi-rigid glass fibre was placed behind the shields. This is condition E in Fig. 1.

The results of the shielding procedure for this arrangement are shown in Fig. 3. It is again clear that there is a significant increase in the measured transmission loss when the frame is shielded from the sound field.

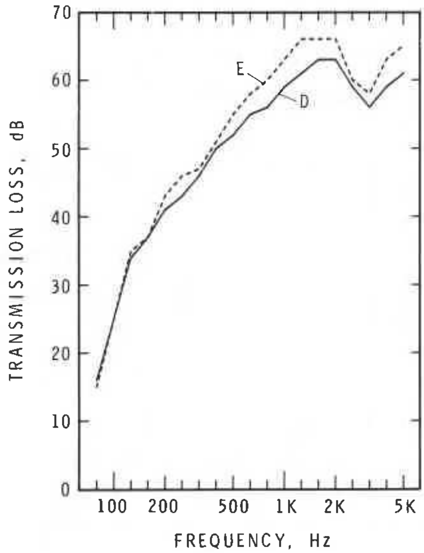


Fig. 3. Measured transmission for shielding conditions D and E, Wall No. 2.

Figure 4 shows the effect of the shields for a wall similar to wall No. 1, the only nominal difference being a slightly thicker layer of low density glass fibre (73 mm). As this latter wall (No. 3) was constructed several years after wall No. 1, there are undoubtedly construction differences that would prevent any meaningful comparison between the two unshielded measurements in Figs 2 and 4. The increased transmission losses due to use of the shields, however, are again quite evident.

Where flanking transmission is along an independent path having a high equivalent sound transmission loss, it becomes significant only when it is comparable with the specimen transmission loss. For this type of enhanced transmission this is not true, as the measurements with and without shields in Fig. 5 clearly show. Here the wall specimen was a single leaf comprising two layers of 13 mm gypsum board screw attached to 41 mm steel studs spaced 610 mm between centres for support (Wall No. 4). Even with this comparatively poor wall the effect of the frame is evident and the differences are significant.

Twelve variations of gypsum board and steel stud walls were examined in this

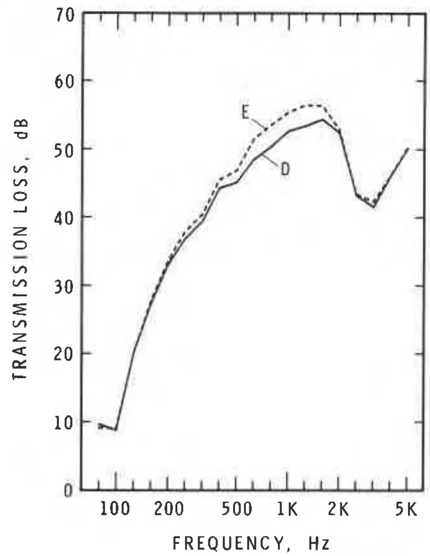


Fig. 4. Measured transmission for shielding conditions D and E, Wall No. 3.

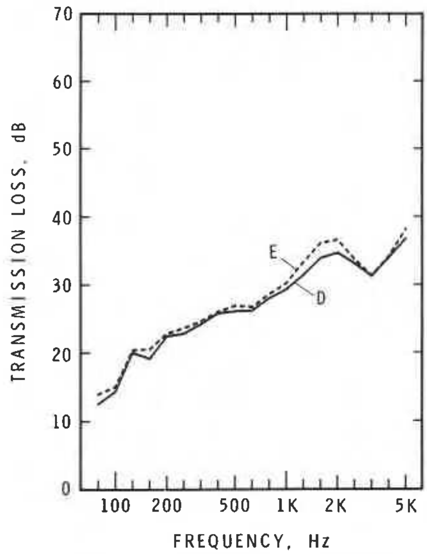


Fig. 5. Measured transmission for shielding conditions D and E, Wall No. 4.

way. In each case there was a marked increase in the measured transmission loss values. An initial attempt was made to calculate the equivalent flanking transmission for this phenomenon, but examination of all the data showed that the effect of the frame varied as the wall changed. Thus any equivalent flanking transmission calculated from the data in Fig. 5 would be meaningless if applied as a correction to the unshielded data in Fig. 3. The simplest way to deal with this problem is to use adequate shielding procedures in all tests.

The influence of the frame in transmission loss measurements was touched on briefly in the model study reported by Michelsen.[3] Jones[4] also discussed some of the effects of specimen frames on measurements but his comments were mainly concerned with the effect of a line connection around the periphery of a double panel, whereas the measurements in Fig. 5 show that the frame can be an important factor in measurements of single-leaf panels.

Although the frame represents, at best, only a stub of a flanking structure, it is nevertheless clear that the coupling between it and the specimen under test acts to increase the measured transmission. The exact nature of the mechanisms involved has not been established.

It is rather obvious from this that the supporting frame should not be attached to any of the test rooms, since the connection and resulting vibrational transfer of energy constitute a form of flanking transmission in contradiction in the stated intent of both ISO 140 and ASTM E90. A supplementary experiment with a wall intermediate in performance between walls Nos 1 and 2 showed that clamping the frame to the receiving room reduced the transmission loss by about 1 dB at 250 Hz. No other effect was discernible.

CONCLUSION

The most important conclusion from this work is that in laboratories where frames are used to support specimens it should be established by measurements such as these that the effects of the particular frame in use are not important or can be eliminated.

ACKNOWLEDGEMENT

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REFERENCES

1. ANON., International Standard ISO 140/1-1978.
2. ANON., ASTM E90-75, Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
3. N. MICHELSEN. *The effects of laboratory design on the measured sound reduction index*, Report No. 18, Lydteknish Laboratorium, Akademiet for de tekniske Videnskaber, 1979.
4. R. E. JONES, Intercomparisons of laboratory determinations of airborne sound transmission loss, *Journal of the Acoustical Society of America*, **66**(1) (1979), pp. 148–64.

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