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MEASURING SOUND LEVELS IN SMALL ROOMS

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Introduction

There are two possible ways of meeting the requirements of the Building Regulations for sound insulation between flats or attached houses (1). Either a deemed-to-satisfy construction may be used or four walls or floors may be tested and shown to reach a certain standard. In the latter case, in the event that the construction is borderline, it is obvious that the measurements should be made with maximum accuracy so that the test is fair. To reduce the errors arising from variations in the testing procedure, various interested parties have been meeting at B.R.E. during the last two years and have produced an agreed testing method (2). Reducing the errors arising from the spatial variations of the sound fields within the rooms, particularly at low frequencies in small rooms, is the subject of this paper.

Means for reducing the spatial variation of the sound field in a reverberant room

Errors arise because the mean sound energy within a room and the mean reverberation time are based on a limited set of microphone positions, six in the agreed method (2). To obtain a better estimate of the mean, without using more microphone positions, it is necessary to reduce the spatial variation of the sound field. Any of the following methods might be tried:-

Multiple Sources
Moving Sources
Stationary Diffusers
Moving Diffusers
Absorbent Panels

Of these, several have obvious drawbacks in that they would take up too much space in a small room and effort was concentrated on absorbent panels and a rotating loudspeaker.

Absorbent panels, designed to operate at low frequencies, have been shown to be effective elsewhere (3), presumably by damping out dominant room modes. Six panels were used in this study, each consisting of a polyurethane foam block 600mm x 600mm x 200mm wrapped in 4 layers of polythene. The six absorbers, stood on their sides around a small room, gave a total absorption of about 5m^2 between 160 and 400 Hz, falling to 3m^2 at 100 Hz and to less than 2m^2 from 630 Hz to 3150 Hz. Typically, this would have the effect of reducing the reverberation time of a small room to between 30 and 50% of its empty value, to more like its furnished state in fact.

The rotating loudspeaker consisted of a loudspeaker sat on a turntable rotating at the relatively low rate of one revolution every 80 s. An integration time of 80 s was used for the sound level measurements in order to cover one complete cycle.

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Results

Measurements of the airborne sound insulation of walls and floors were made in newly erected houses and flats in Salford. Six microphone positions were used in each room and the mean value and its standard deviation were calculated for the level in the source room, the level in the receiving room and the reverberation time in the receiving room. These were then combined to give the normalised sound level difference and its associated standard deviation. The object is to minimise the standard deviation.

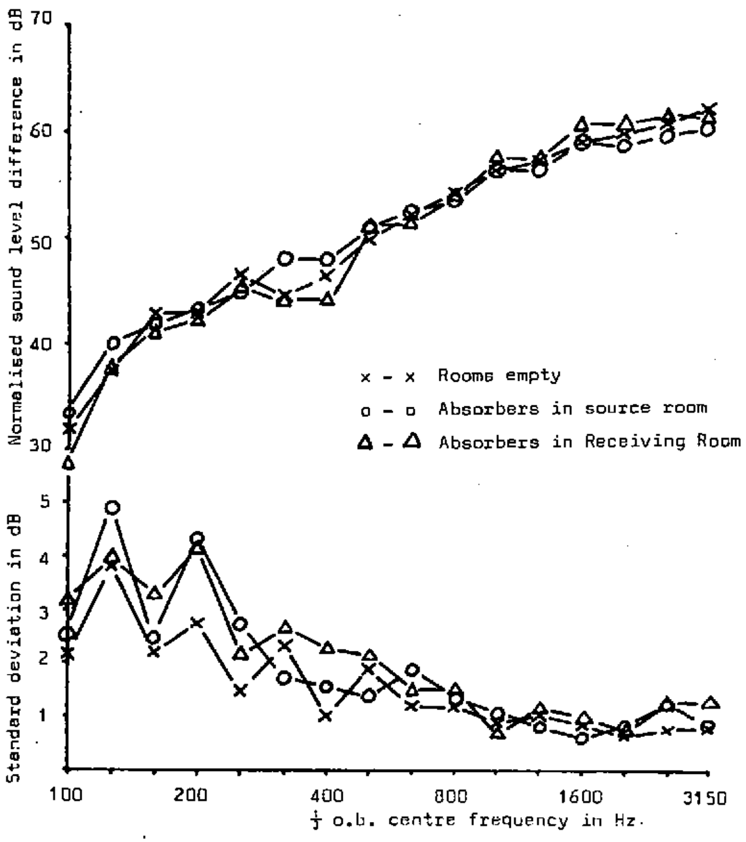

Figure 1.

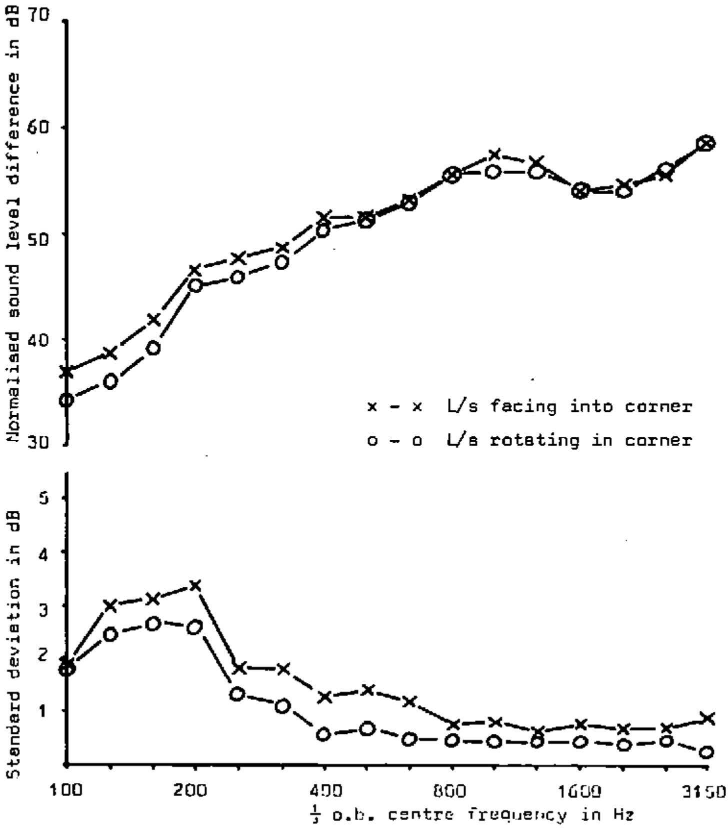

Figure 2.

The reference values are taken as those obtained when a conventional measurement is made, i.e. with a single stationary loudspeaker facing into a corner and both rooms empty. The effect of the absorbers was then tested by repeating the measurements, firstly with all 6 absorbers in the source room and then with all 6 in the receiving room. A typical set of results is shown in figure 1. The loudspeaker was rotated in the same position as when it was stationary, but with both rooms empty, and a typical set of results is shown in figure 2. Measurements were made in several other pairs of rooms and all exhibited similar trends.

Conclusions

Introducing low-frequency absorbing panels into either room has not given the hoped-for reduction in standard deviation. The normalised sound level difference is very similar both with and without the absorbers, but their presence has increased the errors. The only explanation which can be offered is that the diffusion is seriously affected by the absorbers and the adverse effect on the sound field totally outweighs any benefit which might be obtained by damping dominant standing waves. A similar situation arises in large reverberant rooms when it is necessary to use diffusers to maintain a uniform sound field when absorbent material is placed in the room.

Rotating the loudspeaker does show an improvement in that the standard deviation is reduced throughout the frequency range. In fact, there is a reduction in both the source room and the receiving room suggesting that the movement of the sound field is carried through the wall.

The over-riding conclusion, therefore, is that greater accuracy of measurement is most likely to come from creating a more diffuse sound field and further efforts should be in that direction.

References

(1) The Building Regulations 1976. Part G: Sound Insulation. Statutory Instrument 1976 No 1676. London HMSO.

(2) Proposal for a Standard Procedure to measure sound insulation in the field. L.C.. Fothergill, BRE, 1977.

(3) Effects of Source Position, Wall Absorption, and rotating diffuser on the qualification of reverberation rooms. J.Tichy, Noise Control Engineering, Vol 7, No 2, p57, 1976.