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AN IMPROVED TECHNIQUE FOR THE MEASUREMENT OF AIRBORNE SOUND TRANSMISSION IN BUILDINGS

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INTRODUCTION

Measurements of sound insulation in buildings are essential for a knowledge of the performance of the complete structure. Standards exist for the measurements[1,2] and these describe a general procedure to be employed. This consists, quite simply in the case of airborne insulation, of the setting up of a sound field 'as diffuse as possible' in the transmitting room, and of the measurement of the average sound pressure levels in a range of frequency bands in that room and a neighbouring receiving room. The level differences, suitably corrected for the amount of sound absorbing material in the receiving room, represent the required sound insulation between the two rooms.

This procedure is logical and reasonable, but the technique by which it is applied is only described in the standards in the loosest possible terms. No indication is given as to the degree of diffuseness which can be achieved in practice in the source room, nor as to the likely effects of deviations from this ideal. Indeed, no indication is given of the meaning of a diffuse field in the context of these measurements. Some hints are given on the use of loudspeakers for sound sources, but selection of the loudspeaker, and the choice of number and positions in the room are left to the operator. So also are limits on the degree of accuracy and repeatability necessary in the measurements of sound level. It is assumed finally that variations in sound absorption conditions in the measuring rooms in different buildings will be accounted for by the appropriate corrections. Hence no instructions are given regarding the possible use of absorbent materials to simulate the furnishings which will be there when the rooms are inhabited.

As a result of this uncertainty variations arise in practice in the quality of the measuring equipment and in the details of the techniques employed by different operators. These are sufficient to cause discrepancies between results obtained by successive measuring teams in a given building. Even repeated measurements by a particular team can yield significantly different results if sufficient time and care are not taken in the work. Thus there is a need for precision in these measurements, and this is often in direct conflict with practical working conditions on a building site.

MEASUREMENT COMPARISON EXERCISE

A series of comparison measurements have been obtained in a 2-storey building at the Building Research Station. Twelve organisations took part, all of which are engaged in investigations of sound insulation.as part of their regular activities. Each team made two sets of airborne sound insulation measurements between the same pair of rooms. In the first set they used their own equipment and procedures, and in the second set they worked to a procedure laid down in some detail. Hence a measure was obtained of the spread in results from current procedures, and the degree of improvement which might be achieved within practical limitations was determined.

1 CURRENT PROCEDURES

From the twelve organisations who took part, seventeen sets of measurements were obtained. This came about by some organisations supplying two measuring teams, and some teams doing measurements with and without absorbent materials in the receiving room. In all cases the quantity measured was the normalised level difference, corrected to a standard reverberation time of 0.5s.

In summary, the procedures used were as follows:

Three teams used warble tones as a signal source to the loudspeakers and the remainder used random noise. Of the latter, three used a signal replayed from a tape recorder. Bandwidths of the noise source signal were variously 10 per cent, $\frac{1}{3}$ octave, 1/1 octave and wideband. Similar sources were used for measurements of both level difference and reverberation time (for absorption correction) in all cases but one, where an impulsive source (noise from bursting a rubber balloon) was used for the reverberation time. Amplifiers ranged in power output from 4W to 70W, and while loudspeakers were all 250 mm or 300 mm dia, they too ranged in power from 6W to 50W. Five teams used one loudspeaker only and the remainder used two, and while they all positioned the loudspeakers near corners of the source room, none were very precise in the positions and directions they chose.

For the measurements, five teams used moving coil microphones and the others, the condenser type. Six teams used two microphones, one in each room, measuring sound pressure levels in both simultaneously. The remainder used one microphone, investigating the two rooms separately and relying on the monitored signal input to the loudspeaker to set up the same sound field in the source room. There were individual variations in the methods of recording sound pressure levels - most read by eye from a meter, one fed the microphone output direct to a calibrated level recorder chart, and two tape recorded the output for later analysis. The number of microphone positions chosen varied from one to six. Fewer positions were used at the high frequencies, but most teams took five or six positions at the low frequencies. Apart from 'keeping well away from the walls' no care was shown in selecting microphone locations.

A final variation arose from the use of absorbent materials in the receiving room. Four measuring teams employed these and they consisted variously of 8 ft x 4 ft sheets of fibre board, 3 ft square sheets of polyurethane foam, and panels made up of perforated hardboard with a fibreboard backing. One team, while not using absorbent materials as such, did employ an observer in the receiving room, reading sound pressure levels off a sound level meter.

The total spread in the measurements from minimum to maximum varied steadily from 15 dB at 100 Hz down to 5 dB at 800 Hz, and then remained fairly constant up to 3150 Hz. The standard deviation about the mean at each frequency similarly reduced from 4.1 dB at 100 Hz to around 1.1 dB above 800 Hz.

2 PRESCRIBED PROCEDURE

The basic method remained as described in the standards. The approach was to specify the technique to be used in some detail. In outline this was as follows:

(i) A single loudspeaker was employed for the measurement of both level difference and reverberation time. The source signal was random noise, and a brief specification for the minimum requirements of the equipment to be used was given. The loudspeaker cabinet and positioning were also described.

(ii) The sampling procedure for determining the mean sound pressure levels and reverberation times was based on the use of single microphones in both measuring rooms simultaneously. These were swung round on arms, and the limits on the space swept out were again laid down in some detail.

(iii) A prescribed amount of absorption in the receiving room was required.

This time the total spread in the measurements (twelve in all) varied from 10 dB at 100 Hz down to 2 dB at 1250 Hz, but then up to 6 dB at 3150 Hz. The standard deviations were 2-2.5 dB at the lowest frequencies, reducing to 0.4 dB at 1250 Hz and then increasing again to around 1.3 dB at the highest frequencies.

CONCLUSIONS

The scatter in results from current procedures has been demonstrated, and it has been shown that this can be reduced considerably by a detailed definition of the equipment and technique to be used. A further refinement in the procedure would be to make measurements in both directions between a given pair of rooms and to take the average.

REFERENCES

1 Recommendations for field and laboratory measurement of airborne and impact sound transmission in buildings. British Standard 2750: 1956.

2 Field and laboratory measurements of airborne and impact sound transmission. ISO Recommendation R140.