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A SIMPLIFIED FIELD METHOD OF MEASURING THE AGGREGATE ADVERSE DEVIATION OF A PARTITION

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INTRODUCTION

The need for a simplified field method of measuring sound insulation in order to bring about a large scale enforcement of the building codes and thus leading to a significant improvement in the housing stock is widely recognised. A review of past research on the simplified methods of measuring sound insulation /1/ shows a considerable scope for further research, particularly into a method which rates simply and economically the performance of the partition according to the criterion laid down in the British building regulations. The aim is thus to develop a simplified method, capable of accurately predicting the aggregate adverse deviation of a party wall. This is because the main set back of past studies which produced high correlation between single number rating obtained from the full test and from the simplified test, is that partitions with identical single number rating can be classified differently under the British regulations. An example of this is shown in Figure 1.

THE SIMPLE MODEL

Hypothesis

It was decided that the simplified method developed would involve the generation of a noise source and the measurement of the overall sound level using s simple instrument. The hypothesis is that there is a relationship between the overall level difference between the source and the receiving rooms and the aggregate adverse deviation of the partition.

Assumptions

To test the hypothesis, the following assumptions were made: 1) the source only generates a level spectrum over the 16 third octave bands from 100Hz to 3150Hz in the room; 2) reverberation time in the receiving room is 0.5s independent of frequency; 3) the sound fields are diffuse and 4) the 'A' weighting scale is the suitable scale for the measurement of the overall sound levels.

Methods of Computation

For each partition of known transmission loss (TL), two variables are computed - the overall level difference between the source and receiving rooms in dBA (OLD) and the aggregate adverse deviation in dB (AAD).

$$OLD = L_{SA} - L_{RA} \quad \text{dBA} \qquad /1/$$

where L_{SA} is equal to 110 dBA for a flat source spectrum of 100dB and L_{RA} is the 'A' weighted overall sound level in the receiving room and is calculated from $L_R = 100 - TL - Ac$. Ac is the 'A' weighting correction. AAD is calculated according to the British Building regulations.

To obtain a statistically significant regression relation of AAD on OLD, as many as 500 transmission loss data were used in the computation. The data was taken mainly from the BRE national survey and the selection, although random included partitions of different materials, sizes and construction. Recent constructions were also included.

Results

The results are given in Figure 2 which shows a clear linear relationship between the OLD and the AAD. The regression equation is found to be

$$AAD = -11.04\ (OLD) + 591.9 \quad \text{dB} \qquad /2/$$

and a high correlation coefficient of -0.9699 is found. It can be concluded that because of this high correlation, a simplified method which assesses the aggregate adverse deviation of a partition can be developed.

FURTHER INVESTIGATIONS

Further investigations were then carried out to determine: 1) the source type which gives the highest correlation; 2) the most suitable weighting scale for the measurement of the overall levels; 3) the effects of loudspeaker and source room response and more importantly the method of normalising for receiving room absorption.

The analysis of 40 different source types was made and no improved correlation was found. The use of pink noise which is easily generated is therefore justified. For the measurement of the overall sound levels, four different weighting scales were used in the computation (A,B,C and linear). The correlation between OLD and AAD was found to be independent of the weighting scale used for the measurement in the source room. However, for a flat source spectrum, the 'A' weighting scale for the receiving room noise levels gave the highest correlation. The effects of the Nortronic loudspeaker Type 811L and the absorption of unfurnished rooms were studied. As the loudspeaker and room response is frequency dependent, the correlation was affected and a mean deviation in the OLD of -0.85 dBA was found. At this stage of the investigation, it is proposed that parallel third octave filters be used in order to produce a level source spectrum.

In the simple model, the RT of the receiving room is assumed to be 0.5s independent of frequency. The measured overall level difference would have to be normalised for room absorption. Our investigations using measured RT of unfurnished and furnished rooms show that the error in the assumption of RT = 0.5s ranges from 0dB to as high as 6dB depending, of course, on the magnitude of the RT. From this, it is concluded that a simple method of normalising for room absorption has to be developed. Through extensive computation, it is found that the measured overall level difference can be normalised by measuring the RT at 400Hz using the equation

$$OLD_{norm} = OLD_{measured} + 10 \log \frac{RT_{400}}{0.5} \quad dBA \qquad /3/$$

The mean error is found to be 0.5dBA. Further simplification is envisaged by predicting, rather than measuring the RT from the physical parameters of the room.

EXPERIMENTAL WORK

The experimental work was carried out to determine the AAD of partitions using the method described in B.S. 2750 and the simplified method. A total of 7 party walls and 1 party floor were tested. 1 partition was tested in the reverberation chambers. The party floor was measured in well-furnished conditions. The rest of the measurements were conducted in rooms within the University building. The results show that the simplified method, as a screening tool, correctly singles out the failures (where AAD > 23 dB). As a method for measuring the AAD, the agreement is generally good (within ± 10dB) for partitions with AAD < 80dB. For partitions with AAD > 80dB, the agreement is within ± 20dB. However, in these cases of very poor insulation, it can be argued that the simplified method should only need to demonstrate that the AAD would be in excess of 80dB. From the experimental results, it would also appear that small deviations from a level source spectrum are acceptable. The simplified method has also been shown to be repeatable.

SIMPLIFIED METHOD AS AN ALTERNATIVE

Our analysis shows that the simplified method would be capable of isolating 90% of the failures. Of those failures escaping detection, they are mainly partitions of marginal performance and the intrusion of neighbour's noise may not be serious. The simplified method may be supported by a full test although it is only necessary for borderline constructions. The instrumentation involved and the method of measurement is simple and economical. It would involve the generation of a defined source and the measurement of the overall levels in dBA.

The AAD is then predicted from Figure 2 or using the regression equation /2/. Unlike some simplified methods /2,3/, there is no need for computer or elaborate analysis. The method can also be applied to different grading curves.

CONCLUSIONS

A simplified field method for measuring the aggregate adverse deviation has been proposed and evaluated. Our analysis has shown the usefulness of the simplified method in isolating failures accurately and also rating the partition to an accuracy of within 10dB. It is a powerful screening tool, particularly in detecting cases of very poor insulation. There is, however, still scope for further simplification especially that concerning the loudspeaker response and room absorption.

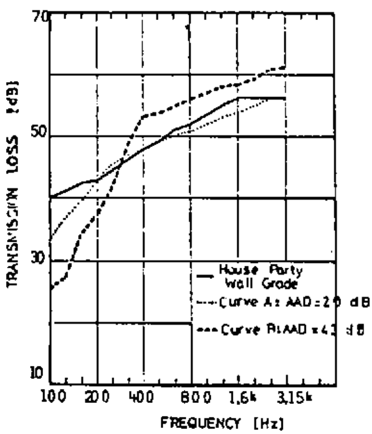

Figure 1 - Sound Insulation Index and the Aggregate Adverse Deviation . Both curves have a Sound Insulation Index of 53

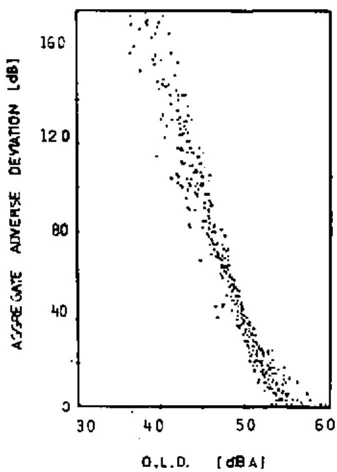

Figure 2 - Scattergram of aggregate adverse deviation and the overall level difference

REFERENCES

/1/ L.J. Lee, "The Simplified Method of Measuring Sound Insulation in Buildings". Unpublished Report, Dept. of Building, Heriot-Watt University, 1981.

/2/ Tricaud, P. de, "Impulse techniques for the simplification of Insulation measurement between dwellings", Applied Acoustics, 8,1975.

/3/ Roland, J. I.O.A. Conference Proceedings, November 1980.