THE APPLICATION OF STATISTICAL ENERGY ANALYSIS TO SOUND TRANSMISSION THROUGH BUILDINGS

Robert J.M. Craik

Heriot-Watt University

Introduction

Statistical energy analysis is a powerful framework of analysis that can be used for many kinds of structure. One important application is to the analysis of sound transmission through buildings where statistical energy analysis can be used to predict the sound pressure level or vibration level at any point in a building for any source.

Coupling loss factors

In order to predict the energy levels at different parts of a building it is necessary to compute the coupling loss factors between the individual sub-systems that comprise the building or part of the building. These calculations can be readily computed using existing theories and a comparison between the measured and predicted coupling loss factors has already been presented (1).

From the sum of the coupling loss factors the total loss factors can be found (2) for the structure and for the rooms the reverberation times can be used to give the total loss factors which are also required for the calculations.

Predicted energy levels

From a knowledge of the coupling loss factors and the total loss factors calculations can be made to predict the energy levels of any subsystems for any source (3). This was done for a part of a building and involved predicting the level of 98 different subsystems with 936 coupling loss factors. For comparison with the predicted results measurements were made of many of the subsystem energy levels for a number of sources. The results for two of the sources can be seen in Figs 1 and 2. In each figure a part of the building is shown in section and against each wall is shown the average octave band difference between the measured and predicted pressure or vibration level. One section is shown for each octave band frequency. Numbers shown in the

THE APPLICATION OF STATISTICAL ENERGY ANALYSIS TO SOUND TRANSMISSION THROUGH BUILDINGS

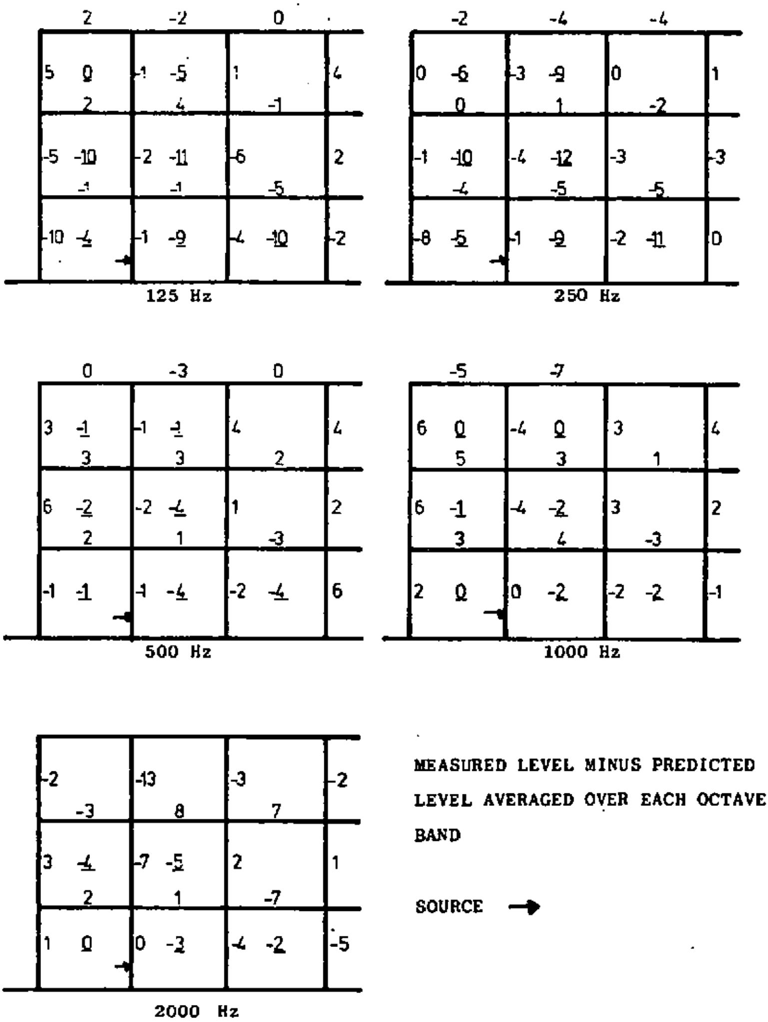

Fig. 1 Difference between measured and predicted energy levels throughout the building

THE APPLICATION OF STATISTICAL ENERGY ANALYSIS TO SOUND TRANSMISSION THROUGH BUILDINGS

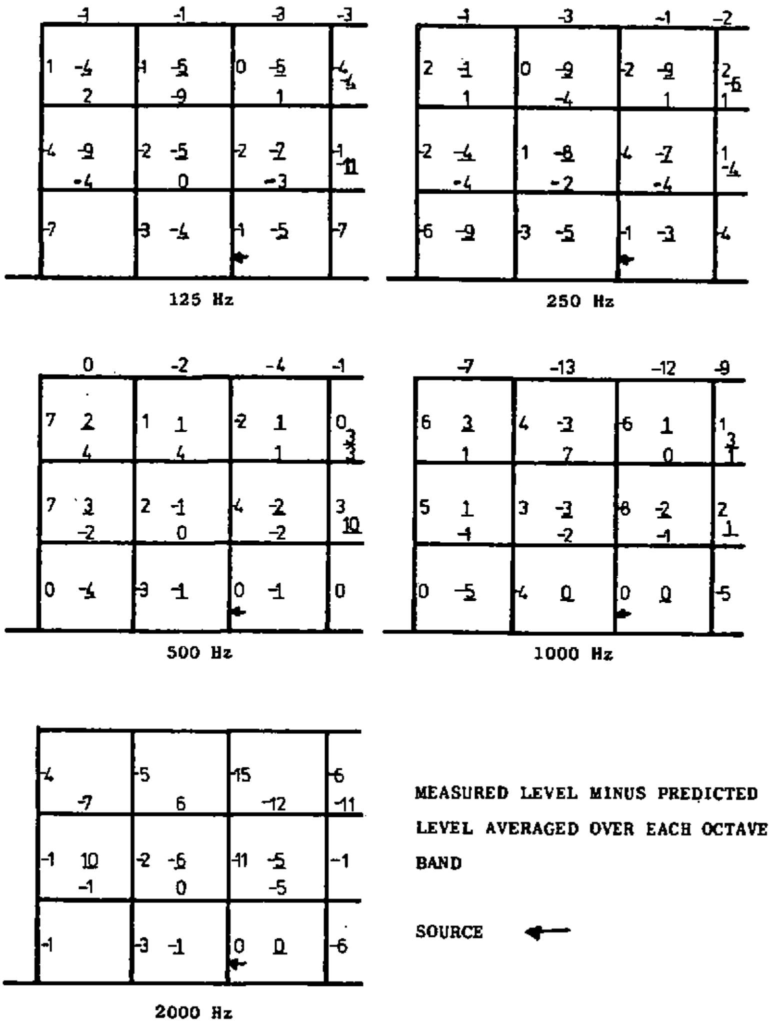

Fig. 2 Difference between measured and predicted energy levels throughout the building

centre of the rooms and underlined represent the differences for the rooms all other numbers refer to vibration level differences.

The results of the two figures show that although there are some differences between themeasured and predicted results most of the differences are small and less than about 5dB. The errors for the rooms at the low frequencies are large and this is due to errors in the predicted coupling loss factors from the walls to the rooms at the critical frequency.

Other large errors occur for some subsystems for example on the walls immediately above the source wall at high frequencies and in each case these errors can be attributed to errors in specific coupling loss factors.

Conclusions

These results clearly show that, to within reasonable limits of accuracy, statistical energy analysis can be used to predict the sound transmission through a building.

Acknowledgements

This work was financed by the Science Research Council.

References

1 Sound transmission through buildings using statistical energy analysis. R.J.M. Craik, Paper 1.13 Institute of Acoustics Spring Conference, London, 1980.

2 The measurement of material properties in buildings. R.J.M. Craik and L.J. Wong, Paper 1.16 Institute of Acoustics Spring Conference, London, 1980.

3 Statistical energy analysis of dynamical systems - Theory and applications. R.H. Lyon. M.I.T. Press 1975.