Proceedings of The Institute of Acoustics

THE ATTENUATION OF LOW FREQUENCY SOUND BY BUILDING FACADES

R. H. CLOUGH

CHELSEA COLLEGE, NOW AT WIMPEY LABORATORIES

INTRODUCTION

Much research has been done on the sound insulation of building facades in the frequency range 100 Hz to 4000 Hz. However, little information is available at frequencies below 100 Hz and therefore this project attempted to measure the low frequency sound insulation of a variety of building facades. The frequency range of measurements was chosen to be 2 Hz to 1 kHz with the results analysed in ⅓ octave bands from 2 Hz and in octave bands from 125 Hz to 1 kHz.

This frequency range includes the fundamental resonant frequencies of most rooms and building facade elements and therefore it was expected that resonances would have a major effect on the measured transmission loss.

MEASUREMENT TECHNIQUE

i) Field measurements

Simultaneous recordings were made inside and outside each building facade in the presence of high levels of external ambient noise, usually due to traffic. Ambient noise had to be utilised, as a portable sound source for the frequency range of interest was not practicable. The external microphone was positioned 1m away from the building facade and opposite the centre of any window. The internal microphone was positioned in a room corner in order to respond to all room resonant modes. Due to the difficulty of measuring the acoustic absorption of room surfaces at the low frequencies under investigation no attempt was made to allow for the effect of the room and therefore the results obtained are for the complete room/window combination.

ii) Laboratory analysis

Various methods of laboratory analysis were investigated. The system which proved most satisfactory was one in which the simultaneous inside and outside tape recordings were traced sequentially onto the same section of level recorder paper, after appropriate filtering. The transmission loss was then estimated visually. This system had the following advantages.

a) Any equipment fault was immediately apparent.

b) The degree of accuracy which could be attached to the results could be observed.

c) If one or other signal fell below the noise floor of the measuring equipment this could be seen.

d) Any spurious noises, especially on the inside signal, could be seen.

THE ATTENUATION OF LOW FREQUENCY SOUND BY BUILDING FACADES

All the previous points could be checked by observing the degree of correlation between the inside and outside signal traces.

THEORY

Of the various theoretical treatments available to describe the situation under investigation the most useful was considered to be that by Guy and Bhattacharya 1973. They derived an equation for the transmission loss of a flexible panel backed by a rigid cavity, in terms of the panel and cavity acoustic impedences and a coupling co-efficient which in turn depended on the panel and cavity resonant mode numbers. This theory has been shown to give good agreement with measurements made on models constructed to be as close to the theoretical ideal as possible. However, for the present results good agreement was not obtained.

RESULTS

A typical result is shown in figure 1. The majority of transmission loss curves followed this shape. The main characteristics of all results were as follows:

i) A transmission loss of between +5 or -5 from 2 Hz to approximately 8 Hz.

ii) A rise in transmission loss at approximately 6 dB per octave to approximately 20 Hz.

iii) A room and window resonance region between 30 Hz and 100 Hz which can reduce the transmission loss to 5 to 10 dB at the resonant frequencies.

Figure 2 shows the result of a test carried out before and after double glazing was installed. The double glazing was achieved by installing an extra frame behind the existing one giving a pane separation of approximately 100mm. It can be seen that the double glazing gives inferior sound attenuation at some frequencies. This is probably due to the additional possible resonant modes introduced by the second panel. At frequencies above 100 Hz however, the double glazing gives greater attenuation than single glazing, as would be expected.

Figure 3 shows the average attenuation of all the measurements made. The shape of these curves are fairly representative of the individual results except individual results all showed resonant variations between approximately 30 and 100 Hz.

REFERENCE

R. W. Guy and M. C. Bhattacharya 1973. Journal of Sound and Vibration, Vol. 27(2), pages 207-223. The transmission of sound through a Cavity Backed Finite Plate.

Fig. 1. Typical result

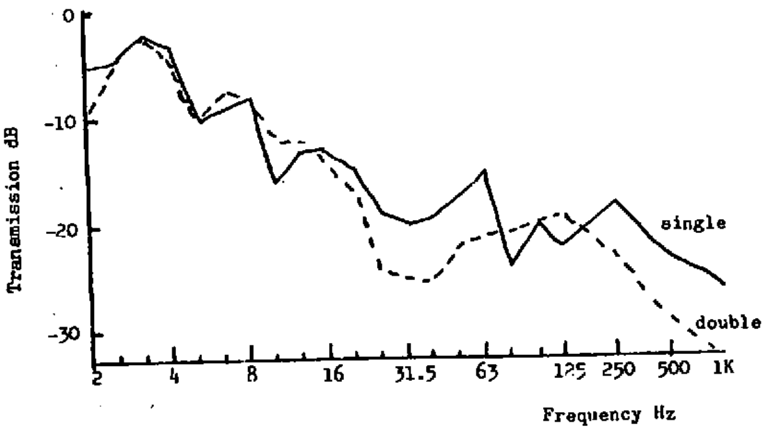

Fig. 2. Comparison of single and double glazing

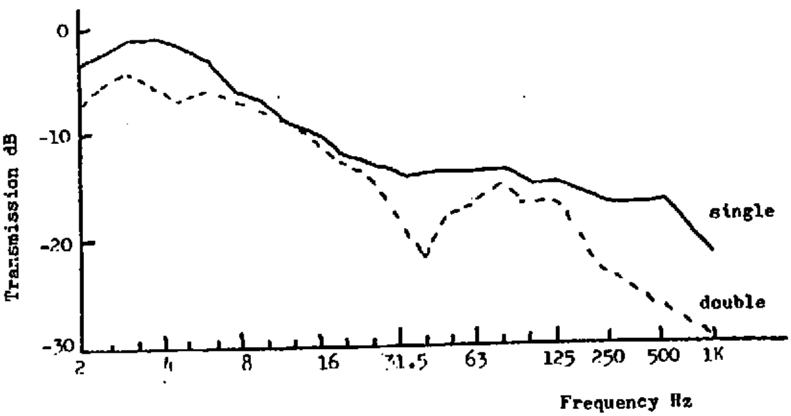

Fig. 3 Average of all results