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MEASUREMENT OF THE SOUND INSERTION LOSS OF VENTILATION LOUVRES

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1. INTRODUCTION

In industrial plantrooms it is often necessary to provide openings, the function of which is to allow air flow to equipment. This link with the outside is likely to cause noise breakout. To avoid such a problem to the environment a louvre that can also provide a reduction in the sound transmission is desirable. Although a wide variety of louvres is available on the market, their acoustic performance cannot be compared meaningfully, as there is no agreed method to characterise their insulation [1]. In this study, a proposed method of measuring the sound insertion loss of ventilation louvres, by an impulse response method, is described which does not require a large scale acoustic installation.

2. MEASURING SOUND INSULATION

The acoustical performance of ventilation louvres is presented by manufacturers using different indices, such as transmission loss, noise reduction index or insertion loss. The diversity of parameters demonstrates the need for standardisation in the method of measuring low insertion loss devices. Briefly, the existing methods can be described as follows:

Standard Method

The majority of data, evaluating louvres, is presented in the form of transmission loss, TL, also known as sound reduction index, which is measured according to ISO 140 [2]. This approach, although appropriate for solid partitions, is not so for low transmission loss devices, as the rooms are acoustically coupled in such circumstances. The lower limit of applicability is a TL of 15 dB which is seldom achieved by open screens such as louvres at low frequencies.

Non-Standard Method
The Acoustic Group of the Heating Ventilating and Air Conditioning Manufactures Association of the UK (HEVAC) propose a test procedure where outside sound pressure levels are measured with and without the louvre fitted in the aperture of a test building. Again, this method requires the provision of a reverberant volume with aperture, ideally, located on an open site [3].

3. IMPULSE RESPONSE METHOD

Unlike the methods described above, impulse response methods do not require special facilities. Instead, the direct, reflected and diffracted components of the transmitted signal are time windowed and the influence of room reflections removed.
Its use to determine the transmission loss of panels was first reported in 1955 [4]. Since then, it has been used to validate theory [5] and in in-situ measurements [6,7].

Excitation Signal
Single impulses give low S/N ratio. Replacing them by a digitally generated sequence of impulses results in an increase in the effective signal intensity. Among the stationary sequences of binary impulses, the maximum-length sequence is widely used [8].

Signal Processing
On obtaining the impulse response of the system, time-of-flight methods are used to window the direct component. The FFT of the anechoic response is then compared with that obtained with the panel between the sound source and the microphone and the insertion loss of the partition thus obtained. The use of a Maximum-Length Sequence System Analyzer/MLSSA permitted a high frequency resolution and the whole process is performed in a single channel system.

4. RESULTS

Acoustic louvres provide acoustic attenuation by a combination of transmission and diffraction mechanisms and these were investigated separately as a prelude to the measurement of acoustic louvres (see Figure 1).
In Figure 2 is the time history and in Figure 3 the resultant insertion loss of a thin solid panel. The latter was obtained from windowing the direct component of the former and a mass law characteristic is clearly seen for normal incidence. In addition, a coincidence plateau is indicated for oblique incidence.
The top edge diffracted component was windowed (see Figure 2) to provide the acoustic screening of a long (4.8m x 1.2m) barrier shown in Figure 4. Results are compared with theory according to Maekawa [9].

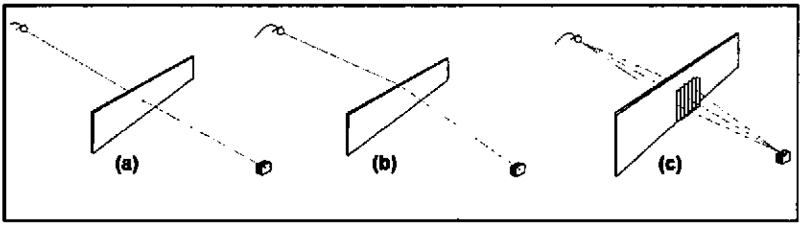

Figure 1 - Time analysis: (a) direct path (b) edge diffraction and (c) internal diffractions.

In Figure 5 are shown the insertion loss, IL, of an acoustic louvre at different angles of incidence. The louvre consisted of five metal blades (200mm x 100mm) with absorbent exposed on one side. At low frequencies the IL increases monotonically with frequency due to the mass layer effect. Here, the IL is independent of angle of incidence. Between 500 Hz - 2 kHz, there is strong angular dependence; the maximum value being for sound incidence parallel to the blades of the louvre. The same trend is also observed above 2 kHz. The angular variation of IL is complicated and is not symmetric. Therefore, a proposed test method, involving impulse response analysis, requires that measurements are repeated for different angles of incidence. In Figure 6 is shown the angle averaged insertion loss of the same louvre, again displaying the mass layer gradient at low frequency and a plateau region at higher frequencies.

Concluding Remarks

Impulse response analysis promises a quick method of test of acoustic louvres without recourse to large scale acoustics facilities. It remains to explore the relationship between the angle average insertion loss with that obtained by ISO 140 and the method proposed by HEVAC.

5. REFERENCES

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Figure 2 - Time history for impulse response

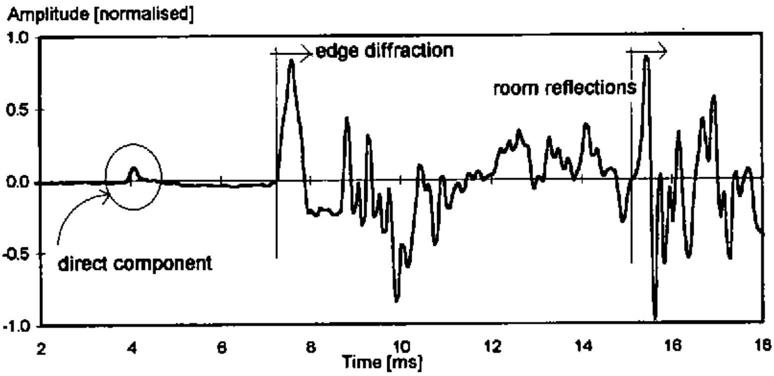

Figure 3 - Insertion loss of a panel

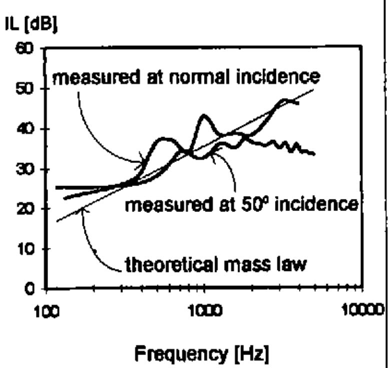

Figure 4 - Insertion loss of a screen

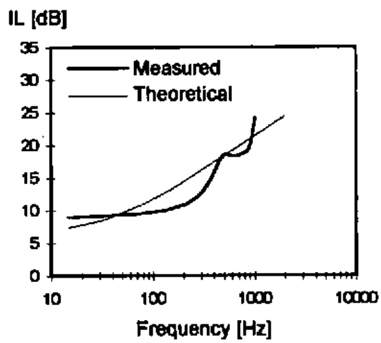

Figure 5 - Insertion loss of a louvre at different angles of incidence

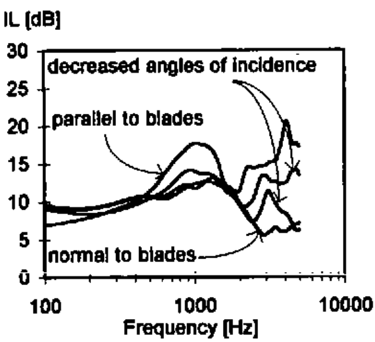

Figure 6 - Angle averaged insertion loss of a louvre in 1/3 oct.