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IN-SITU MEASUREMENT OF SOUND TRANSMISSION LOSS OF MASONRY CONSTRUCTIONS BY ACOUSTIC INTENSIMETRY

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INTRODUCTION

The field measurement of high insulation facades has always posed acoustical problems due to flanking transmission and poor signal-to-noise. The standard recommended method, ISO 140/5 [1], requires an external loudspeaker or nearby traffic as a source, and is used for low insulation facades, such as glazing. It is not suited for high insulation constructions since the method cannot distinguish between higher and lower insulation elements, which are often present. Using sound intensimetry sound radiating through an element is measured directly. Measurements of transmission loss under laboratory conditions have been shown to work successfully [2]. As part of a study of the acoustic characteristics of brick diaphragm walls, field measurements of transmission loss were conducted using sound intensimetry.

Brick Diaphragm Walls

Brick diaphragm walls are often used in the U.K for tall single storey buildings such as sports centres or factory units, as an alternative to steel and concrete frame systems. The general layout of a diaphragm wall is shown within Figure 1. It consists of two widely spaced leaves, typically 0.35 m apart, which are bridged at regular intervals by vertical cross-ribs, typically at 1.25 m centres. This design allows the walls to be built to a height of 7 - 10 m. To date diaphragm walls have not been used for specific noise attenuation applications as their sound insulation was unknown.

FIELD MEASUREMENTS

Six full size diaphragm walls were measured in-situ. The walls were part of sports halls. Normally they provided the external skin to the hall, but sometimes they were also internal party walls.

Unlike the standard field measurement method for transmission loss [1] which requires a receiver room and a sound source external to the facade; in this case the sound source is located internally, producing a diffuse sound field on the wall. The external receiver side of the wall is scanned by a hand-held probe recording pressure and intensity levels. Figure 1 shows the set-up for a typical facade measurement.

The wall was scanned according to ISO/DIS 9614-2 [3], resulting in a single figure surface average intensity level, L_i. A measurement area of 3 m^2 was chosen so that at least two cross-ribs were scanned. The probe was scanned over the measurement area at a distance of 100 mm from the wall surface. This gave a total measurement surface area, including the perimeter, of 3.8 m^2. The scanning speed was typically 0.15 m/s. Two scans, one vertical and one horizontal, were made and the average of the two taken. The transmission loss of the wall is given by:

$$TL = L_P - L_i - 6 \qquad (1)$$

where L_p is the spatial average pressure level in the source room and L_i is the spatial average intensity level over the measurement surface.

The effect of omitting the perimeter was investigated by comparison of results including and excluding the perimeter. None of the surface averages produced any average negative net power flow from omitting the perimeter area. The predominant component of intensity was always from the wall. The reactivity index across the frequency range, with and without the perimeter, varied generally by no more than 1 dB, indicating that energy flow through the perimeter is not significant in these cases.

MEASUREMENT LIMITATIONS

Measurements were recorded in 1/3 octave intervals. The frequency range was limited by the dynamic capability, Ld, of the instrument and the reactivity, L_K, of the measurement field . L_K should always be less than Ld within the frequency band of interest [4]. Figure 2 compares Ld, (solid line), with the range of reactivity indices measured in this study. This indicates that the frequency range for reliable measurements was limited to approximately 100 Hz - 1.25 kHz.

Good signal-to-noise ratios were obtained for the internal wall measurements, as the background noise levels were very low in the receiver room, high source room levels were possible and flanking transmission was minimal.

Measurements through the external facade suffered from a low signal-to-noise ratio, due partly to higher external background noise levels and lower source room levels. However it was also because of noise break-out usually via a lightweight roof and fire doors.

RESULTS

Figure 3 shows the measured transmission loss of six brick diaphragm walls. The two highest curves are those for the internal wall measurements. These are believed to be the most accurate and compared well with the standard measurement method. The effect of a poor signal-to-noise ratio is seen in the external wall measurements, which lie around 5-10 dB lower than the internal wall measurements. However both sets of measurements show the same characteristic shape with some convergence at higher frequencies.

CONCLUDING REMARKS

Prior studies on model diaphragm walls found that the regular bridging by the cross-ribs produced orthotropic radiation characteristics. Intensimetry measurements of the model and in-situ diaphragm walls were compared with Statistical Energy Analysis prediction and showed between fair to very good agreement for the cases studied.

In many cases sound intensimetry may offer a reliable in-situ method of measuring high insulation elements, where the element is the whole facade. Internal wall measurements seemed reliable between 100 Hz and 1.25 kHz and compared well with prediction.

External wall measurements suffered from flanking transmission. However the flanking transmission apparent during these measurements was not shown to significantly influence the reactivity index at the measurement surface or the polarity of average energy flow over this surface. Intensimetry may therefore be applicable in locations of low flanking transmission. Brick diaphragm walls offer a weighted sound reduction index, R_W, of 52 - 56 dB.

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REFERENCES

[1] ISO 140/5 or B.S. 2750 Part 5 (1980) Methods of Measurement of Sound Insulation in Buildings and of Building Elements 'Field Measurements of Airborne Sound Insulation of Facade Elements and Facades'

[2] Halliwell R.E. & Warnock A.C.C., Sound Transmission Loss: Comparison of Conventional Techniques with Sound Intensity Techniques, *J. Acoust. Soc. Am.*, 77(6), (1985) pp. 2094-2103

[3] ISO/DIS 9614-2 (1992) Determination of Sound Power Levels of Noise Sources using Sound Intensity Measurements - Part 2: Method of Measurement by Scanning

[4] Rasmussen, Phase Errors in Intensity Measurements, Intensity Measurements, B & K collection of papers, (1984) pp. 11-18

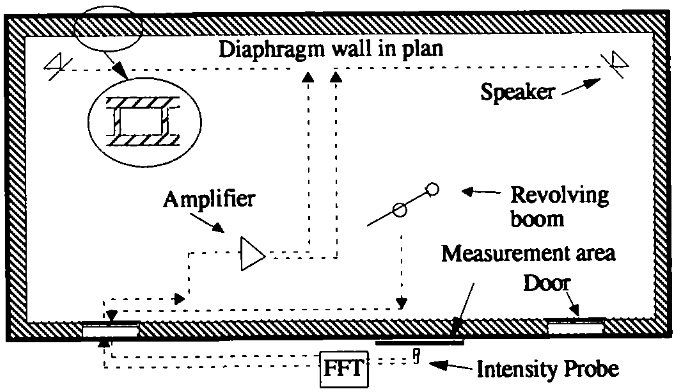

Fig. 1. External wall measurement set-up for transmission loss

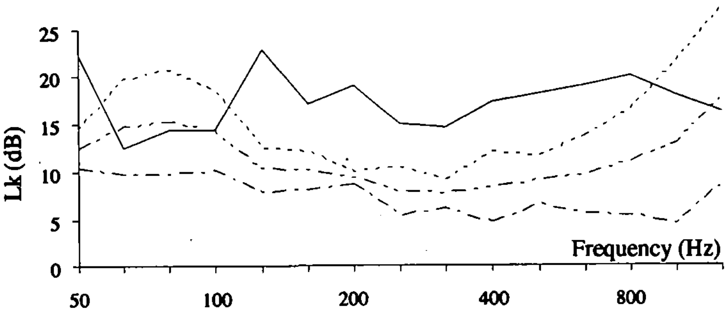

Fig. 2. Reactivity indices of field measurements

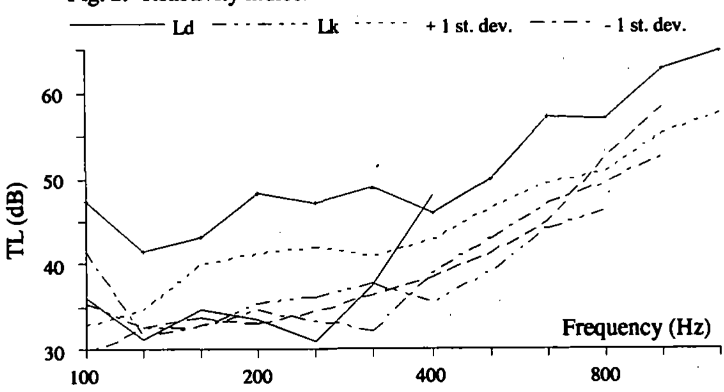

Fig. 3. Transmission loss measurements of six in-situ diaphragm walls