Insertion Loss Characteristics of Barriers and Berms

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INTRODUCTION

Over the past 40 years, much effort has been placed into developing more accurate modelling tools for determining the acoustic performance of barriers and berms for road noise attenuation. Most of the work completed in this field has used ray-based diffraction models which ignore phase information of the acoustic waves [1]. This paper describes initial work completed in computing insertion loss characteristics of various barriers and berms as a function of frequency and distance behind the barrier using a wave-based model. A two-dimensional boundary element procedure has been used to calculate the sound fields of the presented results [2].

A cross-sectional slice of a flat roadside geometry and a simple thin barrier is depicted in Figure 1. Both the source (S) and various receiver (R) positions are shown.

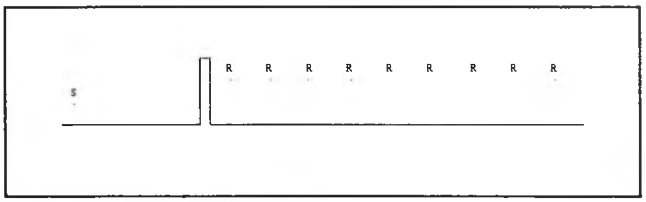

Figure 1 - A Typical Geometry

It has been most common to measure the performance of a barrier in terms of its insertion loss (IL). In many previous analyses [3,4], the insertion loss at one receiver point has been referred to as indicative of the general overall barrier performance. In another study, Hothersall et al. [5], the average of the insertion losses at various receiver points has been used as the basis for rating the barrier. For the current study, it has been chosen to use a range of equidistant receiver positions from 4m to 100m behind the barrier at a height of 1.5m off the ground. In this analysis, 3m high barriers are situated upon hard, level ground and a single line source is placed 15m from the center of the barrier and 0.5m above the ground.

RESULTS

Figure 2 displays insertion loss curves at octave band center frequencies for a simple hard thin barrier (0.2m in width) as a function of receiver distance from the barrier.

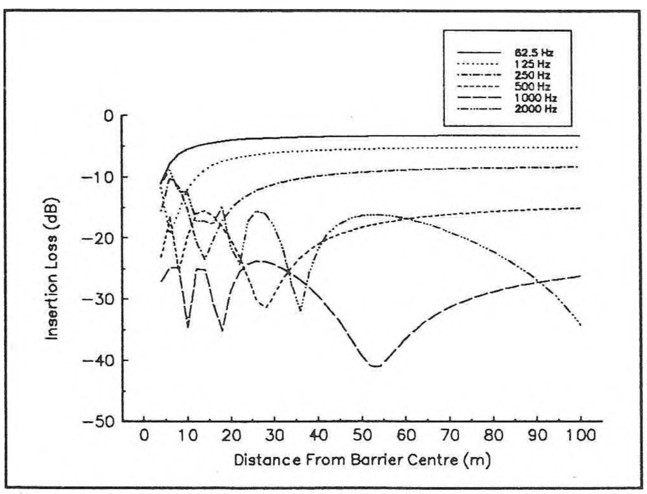

Figure 2 - Thin Barrier Insertion Loss - octave center freq's

It can be seen that at any given distance, depending on the frequency of the sound source, the barrier rating can vary anywhere between 5 and 40 dB's of insertion loss. Thus, selecting a barrier for a specific application or geometry can be quite simple, but designing an optimal shield for the wide range of combinations of the source position, frequency and amplitude, as well as the receiver location and the terrain can be difficult. To further emphasize this point, Figure 3 depicts the insertion loss as a function of both frequency and receiver distance from the thin barrier.

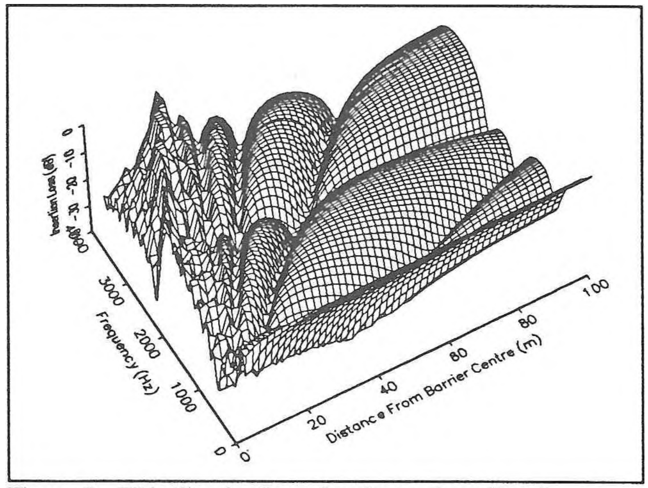

Figure 3 - Thin Barrier Insertion Loss - broadband

Depending on the choice of characteristic frequency or position, any one location on this surface could represent the barrier performance.

While it is practical to obtain a single reading from a physical measurement of the field produced by a broadband source, the wave-based boundary element modelling determines results at discrete frequencies. These results can be combined by making use of an input spectrum of the expected traffic noise. One such measured spectrum [6] is shown in Figure 4. The A-weighting curve and the resulting A-weighted spectrum are also shown.

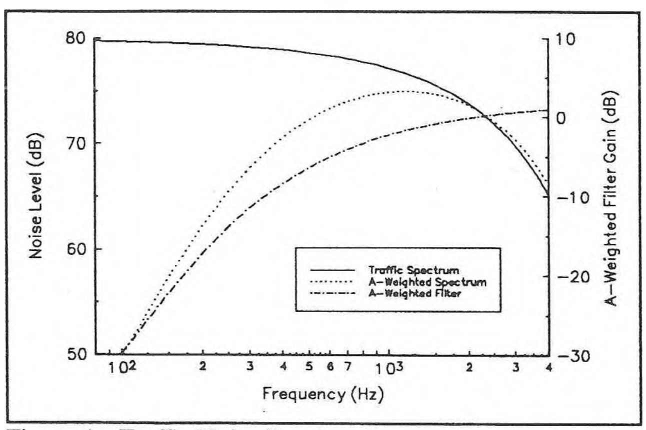

Figure 4 - Traffic Noise Spectrum

This weighted spectrum can act as a *filter* to combine the broadband measurements into one insertion loss curve that is now only a function of distance. Various spectrums, typical of different traffic configurations, could also be tested to evaluate the barrier or berm performance. Working with a single insertion loss curve, as a function of distance for each barrier, the selection of a particular barrier is now simplified. To take this one step further, various schemes are now being investigated to combine or integrate the insertion losses at the receiver positions. In this way a single insertion loss parameter could be used to quantify the barrier's performance.

In addition to the simple thin barrier, various shapes of barriers and berms have been modelled. Figure 5 shows some of the familiar barrier shapes.

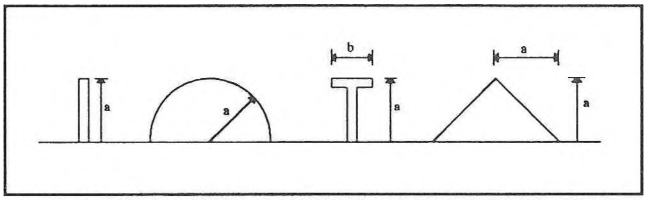

Figure 5 - Barrier Shapes with Dimension a=3m, b=2m

To compare these barriers, insertion loss curves are presented at a frequency of 500 Hz. Several national agencies [7,8] use an insertion loss curve at 500 Hz to be representative of a broadband insertion loss curve. The results of this test are shown Figure 6. The results show that the straight and 'T' shaped barriers are superior by about 3dB over most of the frequency range. More work is planned to investigate optimal barrier and berm geometries for various road configurations.

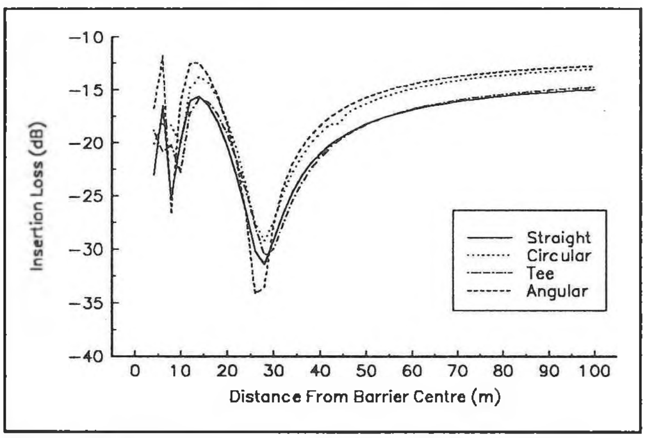

Figure 6 - Insertion Losses of Various Barrier Shapes

In addition to the insertion loss curves presented, sound level contour plots can be used for a quick and accurate visual comparison of fields with and without a barrier. Figure 7, for example, depicting a raised road geometry, is included as an example of these modelling capabilities. Sound levels, for this 500 Hz test, range from 100dB near the vehicles to 50dB in the shadow regions.

Ongoing studies are investigating the application of absorbative linings to both the barriers and on the ground surfaces in the shadow region of the barrier. As well, the effect of various road-side geometries on the performance of the barriers are being studied.

ACKNOWLEDGEMENTS

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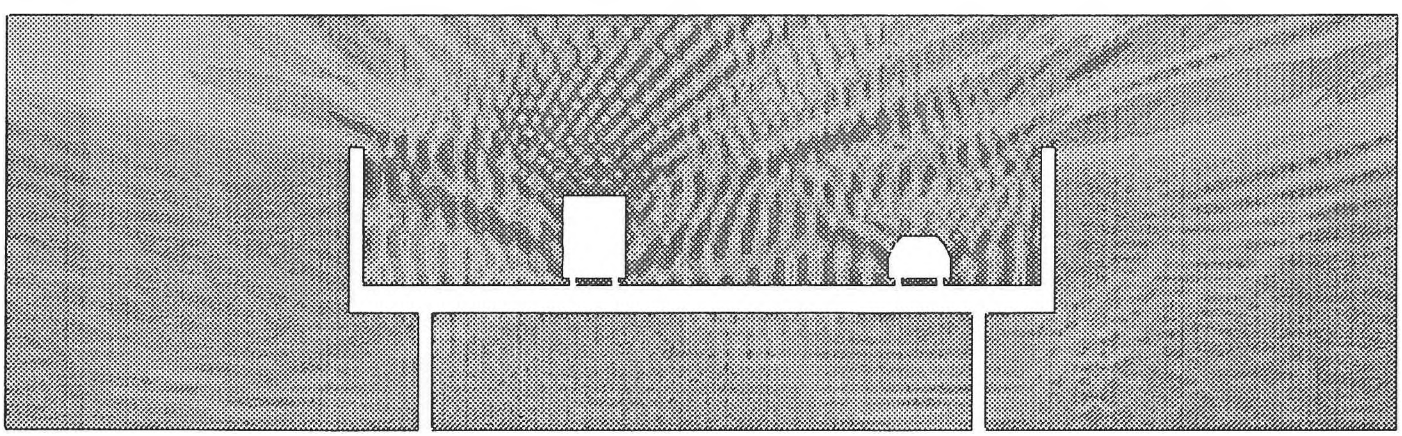

Figure 7 - Sound Pressure Contours for Raised Highway with Barriers