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PREDICTION AND THE EFFECTS OF PARALLEL ROAD TRAFFIC NOISE BARRIERS

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1. INTRODUCTION

Noise barriers are commonly used in the abatement of road traffic noise. Where protection is required on both sides of a road parallel barriers may be constructed. The Insertion Loss obtainable behind a single barrier can be seriously degraded when a second parallel barrier is introduced on the opposite side of the road. The effect is well known and the two methods most commonly used to overcome this degradation are a) to make the surface of the barriers facing the traffic absorbing or b) to slope outwards the surfaces of the barriers facing the traffic. A number of numerical models have been developed which are able to describe these effects [Eg.1, 2] using ray tracing techniques to define the reflections and usually incorporating various adaptions of wave theory and empirical results.

An accurate method of calculating the wave field in the region of a noise barrier is to solve the wave equation using the boundary element method [3]. The method allows the barrier shape and surface cover to be modelled in detail. In this paper the boundary element method is used to examine the effects of some constructional details on the Insertion Loss degradation of parallel barriers.

2. DEGRADATION IN INSERTION LOSS FOR SLOPING PARALLEL BARRIERS

The boundary element model assumes two point sources of sound and the calculation is carried out in two dimensions in a vertical plane perpendicular to the line of the roadway. While it is not possible to predict absolute values of traffic noise without the inclusion of empirical factors the model is successful in comparing the effects of different configurations of noise barrier. For example in Figure 1. the degradation in Insertion Loss (ΔIL) for parallel rigid barriers, 2.0m in height, with a separation of 32m is plotted as a function of the angle of the barriers to the vertical. The receiver position is 3.0m above the rigid ground, 50m behind one of the barriers. Results have been calculated using the ray model which predicts L_{10} traffic noise levels CROSECT [2] and the boundary element model. The agreement is generally good. In the latter model a broad band source with a spectrum characteristic of road traffic noise was assumed. The observed differences can be related in some degree to the different source positions used in the two models. In the CROSECT model the source was 0.5m above the carriageway and 8m from the barrier adjacent to the receiver. For the boundary element model the sources were assumed positioned at 9.75m from each barrier at 0.5m above the carriageway. As can be seen ΔIL quickly reduces to values close to zero as the angle increases. This is a well known and generally observed trend, however, the detail of the angle at which ΔIL becomes small is dependent upon the geometry considered, in particular the position of the sources.

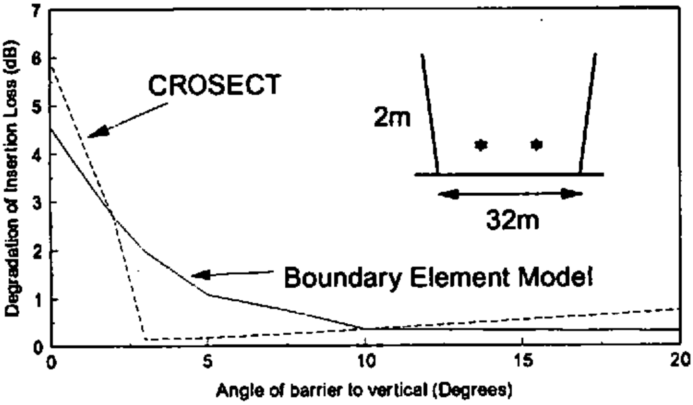


Figure 1.

Figure 2 shows the Insertion Loss spectrum at a receiver position 50m behind the barrier in the ground. Results are plotted for a single vertical reflecting screen 2.0m high and for similar parallel screens 32m apart. The calculation was carried out at third octave centre frequencies using the boundary element method with the sources in the positions described above. A fairly smooth increase in IL with frequency is observed for the single barrier. Reflections between the barriers in the parallel configuration make the spectrum much more variable and a degradation of Insertion Loss is observed over significant regions of the spectrum.

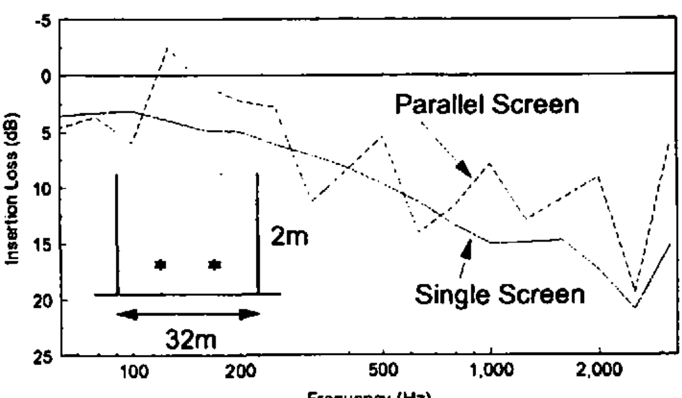


Figure 2.

3. EFFECTS OF PROFILED VERTICAL SCREENS

The construction of sloping thin screens at a small angle to the vertical is possible. However, in terms of efficiency of construction and compatibility with existing commercial unit barrier designs it is desirable that the screen is essentially vertical. In this case a slope could be achieved by profiling the surfaces of the barriers facing the road. For a design consisting of stacked panels, say 0.5m in height a barrier 2m in height could be profiled as shown in figure 3a). The performance of this profile and the others in Figure 3 can be modelled using the boundary element method. In Table 1 the degradation in the Insertion Loss over a single, plane vertical screen is given for receiver positions at distances D(m) behind one of the barriers and height h(m) above ground. For each profile from Figure 3 angle α was 10°. From the table it can be seen that the effect of changing the angle β between 90° and 70° is small. When the sloping surface of the barrier in Fig 3c) is divided into several elements (Figs 3a) and b)) ΔIL rises significantly.

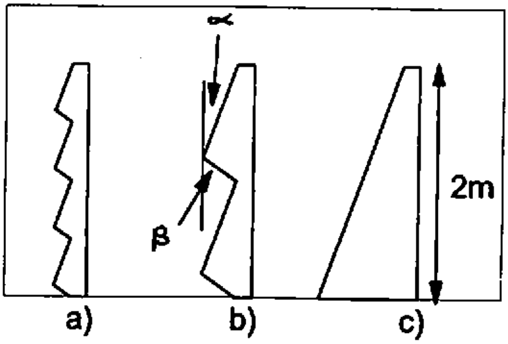
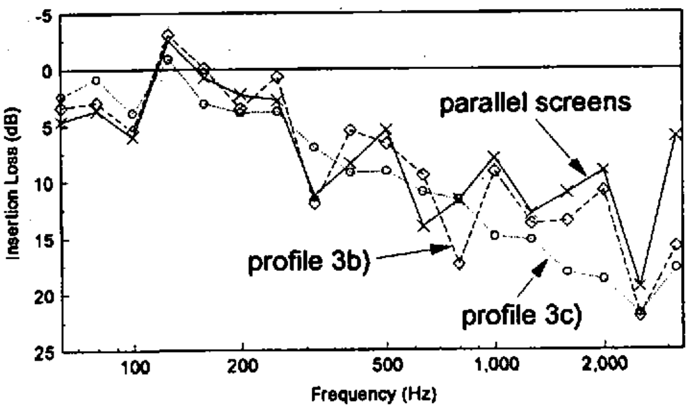


Figure 3.

Degradation in IL dB(A)						
Profile	D=20 h=1.5	50 1.5	100 1.5	20 3	50 3	100 3
Vertical, plane	3.7	3	3.3	5	4.6	3.5
Fig 3a), β =90°	2.5	2.7	2.8	2.6	3	3
Fig 3a), β =70°	2.8	2.7	3.1	3.1	3.2	3
Fig 3b), β =70°	2.5	3.7	3.5	2.8	2.9	3.9
Fig 3c), β =70°	0.9	1.1	1	0.6	0.8	1.1

Table 1.

Figure 4 shows spectra of Insertion Loss for parallel vertical, plane barriers 2m high (x) and for barriers with the profiles in Figure 3b) (◊) and Figure 3c) (o). The receiver was at D=50m, h=0m and α=10°. The spectrum for the profile in Fig 3c) resembles that for a single screen in Figure 1. The other two spectra show some similarity. Above 800 Hz the result for the profile in Fig 3b) is always lower than that for the vertical plane screen.



CONCLUSIONS

It is consistently observed that sloping plane barriers will markedly reduce the Insertion Loss degradation from that observed for vertical plane screens. Specific predictions of these effects using ray or wave models are strongly dependent upon the source distribution adopted in the model. Even if a range of source positions is included the effects of reflections from vehicles could be significant.

For the situations considered dividing the sloping plane into a series of vertically stacked sloping sections considerably reduced the efficiency of the design since in this case the sections act as scatterers of the sound.

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