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PERFORMANCE OF MEDIAN NOISE BARRIERS

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ABSTRACT

It is possible to incorporate 'median' barriers as a noise control measure on the central reservation of dual carriageway roads. The purpose of this paper is to investigate the performance of these barriers alone, and in conjunction with roadside barriers. A numerical model is used which simulates the traffic as six incoherent line sources of sound. The results for insertion loss show remarkable consistency over a range of receiver positions. The median barrier produces an insertion loss of about 1dB for propagation above rigid ground and 2dB for grassland. This can be added to the predicted insertion loss of roadside barriers to give the result for the combination.

1 - INTRODUCTION

On dual carriageway roads it is possible to use barriers on the central reservation as a noise control measure. These will be called 'median' noise barriers. Space is usually available to construct such barriers, which may require protection by the usual traffic crash barriers. The lanes closest to these barriers are generally occupied by passenger vehicles travelling at high speed. For such vehicles the main source of noise is the tires. Some interruption of sight between the two carriageways is desirable for many road configurations and median barriers also fulfil this requirement. A commonly proposed design for such barriers is that they should be low, say 1m in height, and have surfaces which are capable of absorbing sound. This design may be argued to be efficient since the major sound source is close to the ground and close to the barrier.

Median barriers have been proposed by other workers. Watts [1] considered the possibility of a median barrier placed in between two parallel barriers, 2m in height, separated by a distance of 34m. Measurements were undertaken at the Noise Barrier Test Facility at the Transport Research Laboratory. Results suggested that a median barrier of height 1.25m improved the overall screening, with noise levels 1dB lower than with a single, reflective 2m barrier. Results were also compared with results from a 2D boundary element model simulating coherent line sources of sound.

The numerical modeling method used in this work simulates the effects of incoherent line sources of sound. The results for sound propagation above ground planes which are rigid and have finite impedance appropriate to grassland are compared with the results of the standard UK prediction method [2]. The model is then used to assess the performance of median barriers in reducing noise when installed alone and with associated roadside barriers.

2 - DESCRIPTION OF NUMERICAL MODELS

The 2D problem is considered, in a vertical plane perpendicular to the line of the barrier and the parallel source lines. The wave equation, expressed as a boundary integral equation, is solved using standard boundary element methods. This allows great flexibility in the specification of the shape, position and surface impedance of the barriers, the characteristics of the ground surface and the source positions. The solution has been described before [3] and the results are equivalent to those for a 3D system with barriers of uniform characteristics along their length and coherent line sources of sound. The solution as a function of frequency can be transformed into a pseudo 3D solution appropriate for an incoherent line source using the transformation given by Duhamel [4]. Only the real parts of the integral were used.

The sound field was calculated at third octave center frequencies between 63Hz and 4kHz for a typical road traffic noise source spectrum. The excess attenuation is the reduction in the broad band, free field SPL which results from the given propagation conditions. The insertion loss is the reduction in broad band SPL when the barrier is introduced.

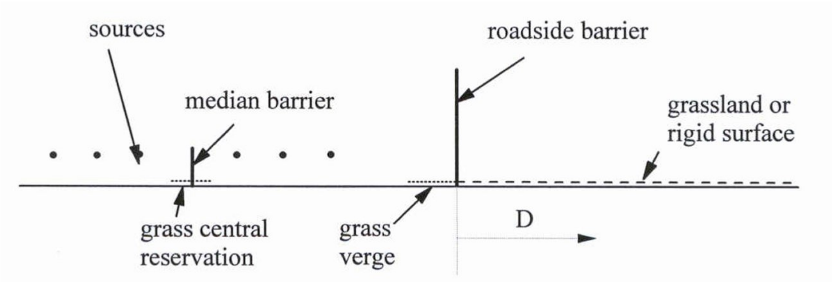


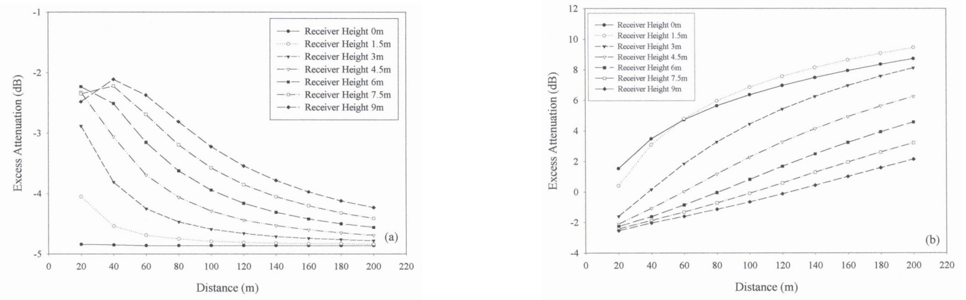
Figure 1: Site conditions.

The site conditions considered are shown in the cross-section in Figure 1. Six source lines were used, corresponding to three streams of vehicles on each of two separate carriageways. The lane widths were 3.5m and the sources were positioned at the center of each lane at 6.25m, 9.75m, 13.25m, 18.75m, 22.25m and 25.75m from the roadside barrier. The source heights were 0.5m for the results in section 3.1 and 0.1m for the results in section 3.2. The road surface was assumed to be rigid. A one meter grass verge, 3.5m hard shoulder and 2m central reservation were also included as shown in the figure. Reception points at various distances, D from the roadside barrier position, and heights above ground level were considered. The grassland was assumed to have surface impedance described by the Delany and Bazley model [5] with flow resistivity of 350,000 Ns/m^4.

3 - RESULTS AND DISCUSSION

3.1 - Ground attenuation

Figure 2 shows the excess attenuation as a function of distance D when no barriers are present. Figure 2a is for propagation above rigid ground. Incoherent line sources are used. As the distance increases the excess attenuation for each receiver height appears to be converging to about −5dB. Due to the presence of the grass verge and central reservation the theoretical limit of −6dB is not achieved. Figure 2b is for propagation over grassland. The excess attenuation increases with distance for each receiver height.



(a) **(b)**

Figure 2: Excess attenuation for the incoherent line source model for unobstructed propagation over a) rigid ground and b) grassland.

Subtracting the grassland excess attenuation from the rigid ground excess attenuation enables the ground absorption effect of the grassland to be assessed. Predictions at a receiver height of 4.5m are shown in Figure 3 for both the coherent and the incoherent line source numerical models and from the standard UK traffic noise prediction method [2]. It can be seen that the coherent source model produces higher values of ground attenuation than the incoherent model and at larger distances both models over-predict the attenuation in comparison with the standard model. This is possibly a result of the effects of atmospheric refraction which will have occurred in the measurements from which the standard method is derived but is not considered in the numerical models.

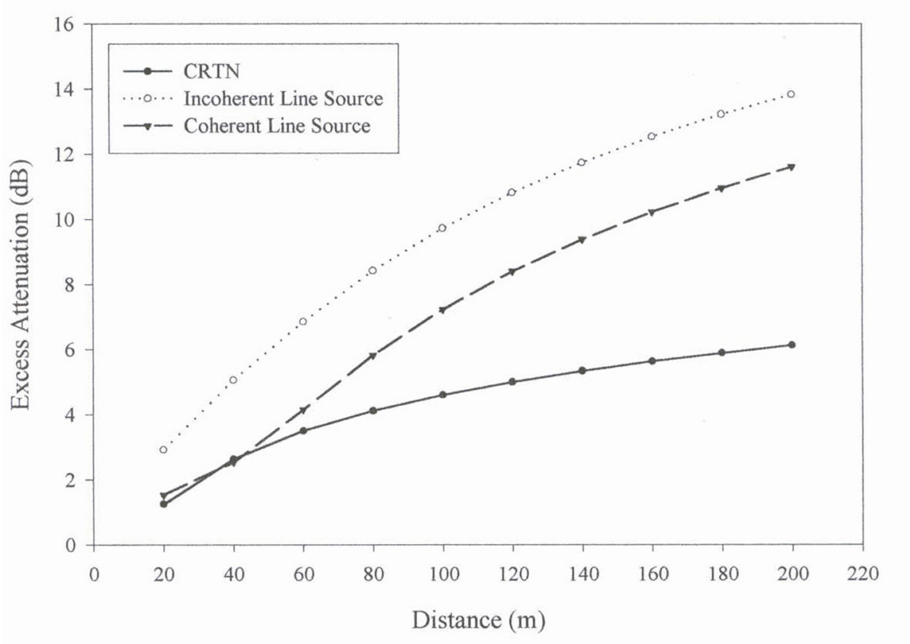


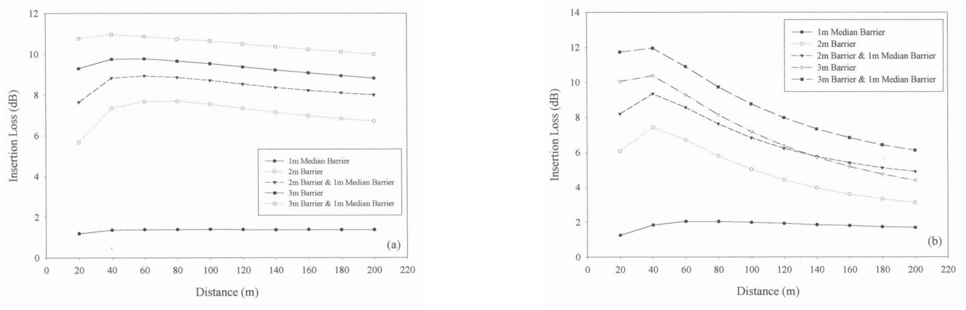
Figure 3: Comparison of the results of the two numerical models and the standard UK prediction method for ground absorption due to grassland.

3.2 - Median barriers

The median barrier, 1m in height, was positioned as shown in Figure 1 and had surfaces of finite impedance. This was calculated assuming a hard backed fibrous layer with a flow resistivity of 20,000 Ns/m^{4} and layer depth of 0.1m. Figure 4 shows the insertion loss as a function of distance, D for the median barrier, for roadside barriers of 2 and 3m in height, and for combinations of the median and roadside barriers. Figures 4a and 4b are for rigid ground and grassland respectively. The receiver height is 4.5m.

The median barrier alone produces a very consistent insertion loss of between 1 and 2 dB for the distances investigated, up to 200m. The results for grassland are about 0.5 dB higher than for rigid ground. As expected the insertion loss of the 3m roadside barrier is 2dB higher than for the 2m barrier. The reduction in insertion loss with distance for the grassland case is a result of the extra ground attenuation for unobstructed propagation over grassland.

The insertion loss of the combined barriers is approximately 1dB higher than the value for the corresponding roadside barrier alone. The results for the grassland are again about 0.5dB higher than for rigid ground.



(a) **(b)**

Figure 4: Insertion loss for various barrier configurations. a) is for rigid ground, b) is for grassland.

4 - CONCLUSIONS

A numerical model has been used to investigate the sound attenuation achievable by median noise barriers. A median barrier, of the type considered, when used alone, provided a consistent insertion loss of the order of 1dB for rigid ground and 2dB for grassland. When combined with roadside barriers the median barrier enhanced the expected insertion loss of the roadside barrier by these values for the two ground cases. These results were observed for distances between 20 and 200m from the roadside barrier and at receiver heights up to 7.5m. The consistency of the results is attributable to the broad averaging taking place over the propagation conditions for the six, incoherent, line sources. The results are broadly in agreement with the measurements of Watts [1].

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