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# SOME EFFECTS OF TRAFFIC NOISE PROPAGATION

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This paper outlines a method of examining the effects of a complex built environment on the propagation of noise from road traffic. The method is based upon the derivation of the noise level as a function of distance from an observation position during the passage of an individual vehicle. The temporal noise probability distribution function for a stream of vehicles is then generated using a statistically valid combination of the individual vehicle result using the method given by Nelson (1).

## Single vehicle S.P.L. vs distance functions

The S.P.L. at an observation position during the passage of an individual vehicle can be expressed as a function of the distance of the vehicle down the road ($\ell$). $\ell$ is measured from the point on road closest to the observation position. At this point the distance from the vehicle centre line to the observer is d. If the road is straight, the relation is:

$$S.P.L(\ell) = L_R + 10F \log_{10} R - 5F \log_{10} (\ell^2 + d^2)$$

Where $L_R$ is the reference S.P.L. for a vehicle measured at a distance R.
and F is a ground cover index.

The S.P.L. at $\ell$ = 300 m derived from this equation is at least 25 dB(A) lower than the peak S.P.L.

In most practical situations the contribution to the total S.P.L. at the observation position due to vehicles beyond this distance can be validly ignored. The functions were truncated at 300 m and the effects of screening and reflection were applied as modulations to the basic function.

The extent of screening and reflection effects was determined by geometrical ray construction.

## Screens

In this case the noise reduction by a screen is that of a point source. Maekawa's work on scale models (2) resulted in a design chart relating excess attenuation, of sound from a point source due to a screen, to the function 2D/λ, where D is the path difference between the direct and diffracted sound paths and λ is the wavelength of the sound. Delany (3) fitted polynomial expressions to Maekawa's data. The point source polynomial expressions obtained by Delany, together with the individual vehicle noise spectra for the two vehicle classes,

1) light vehicles < 1500 kg
2) heavy vehicles > 1500 kg

determined by Lewis (4), were used to calculate the excess attenuation. This excess attenuation was calculated by summing logarithmically the attenuations for each octave band of the noise spectrum for the vehicle class and applying an 'A' weighting. The basic distance-level distribution was then modulated by the excess attenuation at intervals of 1m along the appropriate parts.

## Reflections

The magnitude of the reflected sound wave was determined from the ray path lengths using the usual distance attenuation function. On each reflection 20% of the incident sound energy was assumed to be retained at the reflecting surface. The figure of 20% has been used by other investigators (5) to account for absorption and scatter at the facade of buildings when this figure and the combination process is used, a reflecting surface one metre behind an observation position produces an increase in noise level of 2.5dBA over a wide range of source-observer distances and traffic parameters. This agrees well with existing noise prediction techniques(6). As before, the basic distance-level distribution was modulated, this time by summing the direct and reflected S.P.Ls logarithmically.

## Results

Figure 1 shows a sketch of the site chosen to compare the developed model with measured noise levels. The building shown was situated mid-way along a stretch of straight roadway with no other obstructions other than those shown. The traffic volume was in the range 600-800 v.p.h. with 10% heavy vehicles. A one hour noise survey was carried out at each of the positions A-D using the standard procedure and with the microphone at 1.2m above ground level. Table 1 is a comparison between measured and predicted values of $L_{10}$, $L_{50}$, $L_{90}$ and $L_{EQ}$. Figure 2 illustrates the effects of screens and reflectors on the basic individual distance-level noise distribution at position C using the techniques described. Figure 2 also shows details of the geometrical construction.

## Discussion and Conclusion

From table 1, the method outlined shows good agreement with the measured results at all positions, particularly for the $L_{10}$, $L_{50}$ and $L_{EQ}$ indices. Three further factors need to be considered which would give a further improvement in accuracy.

(A) The method does not assume any ambient noise level at each of the positions. An ambient level of 42dBA was recorded at the site, and when this was added to the $L_n$ indices a considerable improvement at the $L_{90}$ level occurs, table 1 (last column).

(B) The ray approach to diffraction does not allow for gradual changes of level at the vertical edges of screens as is expected from diffraction theory. A Fresnel zone approach would allow this effect to be incorporated in the modulation functions for screens.

(C) Closer agreement between the measured and predicted $L_{10}$ level at position C would be obtained if secondary reflection effects between the wall and building were included.

## References

(1) P.M.NELSON T.R.R.L. Laboratory Report 611. A computer model for determining the temporal distribution of noise from road traffic.

(2) Z. MAEKAWA 1968 Applied Acoustics 1, 157-173. Noise reduction by Screens.

(3) M.E. DELANY 1972 NPL Acoustics Report AC57. A practical scheme for predicting noise levels ($L_{10}$) arising from road traffic.

(4) P.T. LEWIS 1973 Journal of Sound and Vibration 30(2), 191-206. The noise generated by single vehicles in freely flowing traffic.

(5) A.D. CLAYDEN, R.W.D. CULLEY and P.S. MARSH 1974 Applied Acoustics (8) 1-12. Modelling traffic noise mathematically.

(6) D.O.E. 1975 Calculation of road traffic noise.

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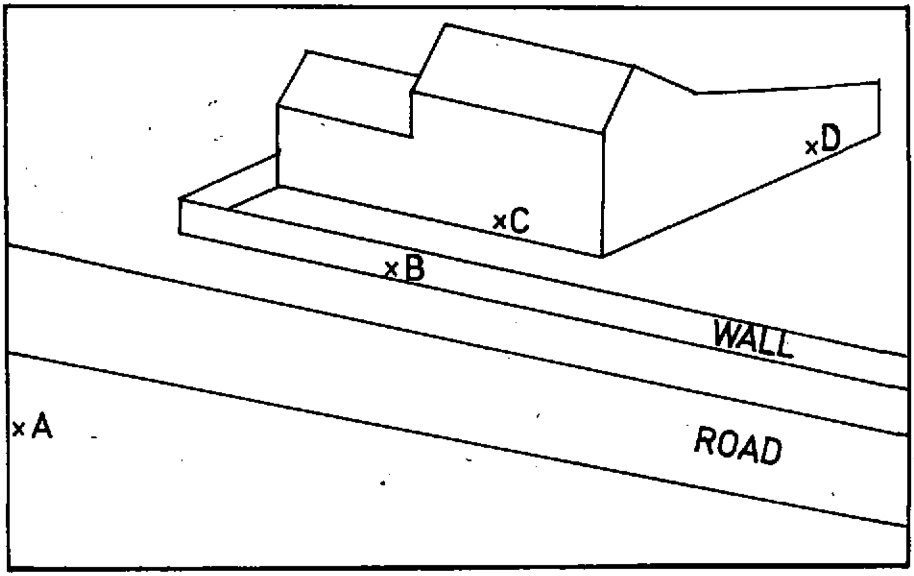
Table 1 Comparison of predicted and measured values of noise indices

| Position | | Predicted Value dBA | Measured Value dBA | Residual Predicted -Measured | Predicted Value Plus Ambient dBA | Residual and Predicted -Measured |
|---|---|---|---|---|---|---|
| A | L10 | 71.4 | 72.3 | -0.9 | 71.4 | -0.9 |
| | L50 | 58.7 | 58.6 | 0.1 | 58.8 | 0.2 |
| | L90 | 45.8 | 47.5 | -1.7 | 47.3 | -0.2 |
| | LEQ | 67.9 | 68.2 | -0.3 | 67.9 | -0.3 |
| B | L10 | 76.2 | 77.0 | -0.8 | 76.2 | -0.8 |
| | L50 | 59.5 | 58.8 | 0.7 | 59.6 | 0.8 |
| | L90 | 45.6 | 46.5 | 0.9 | 47.1 | 0.6 |
| | LEQ | 72.5 | 72.9 | -0.4 | 72.5 | -0.4 |
| C | L10 | 65.0 | 66.5 | -1.5 | 65.0 | -1.5 |
| | L50 | 55.8 | 55.1 | 0.7 | 56.0 | 0.9 |
| | L90 | 43.9 | 46.3 | -2.4 | 46.1 | -0.2 |
| | LEQ | 62.5 | 62.1 | 0.4 | 62.5 | 0.4 |
| D | L10 | 59.0 | 58.5 | 0.5 | 59.1 | 0.6 |
| | L50 | 49.2 | 51.8 | -2.6 | 50.0 | -1.8 |
| | L90 | 39.9 | 46.3 | -6.4 | 44.1 | -2.2 |
| | LEQ | 56.0 | 54.6 | 1.4 | 56.2 | 1.6 |

Figure 1 The site location and measurement positions



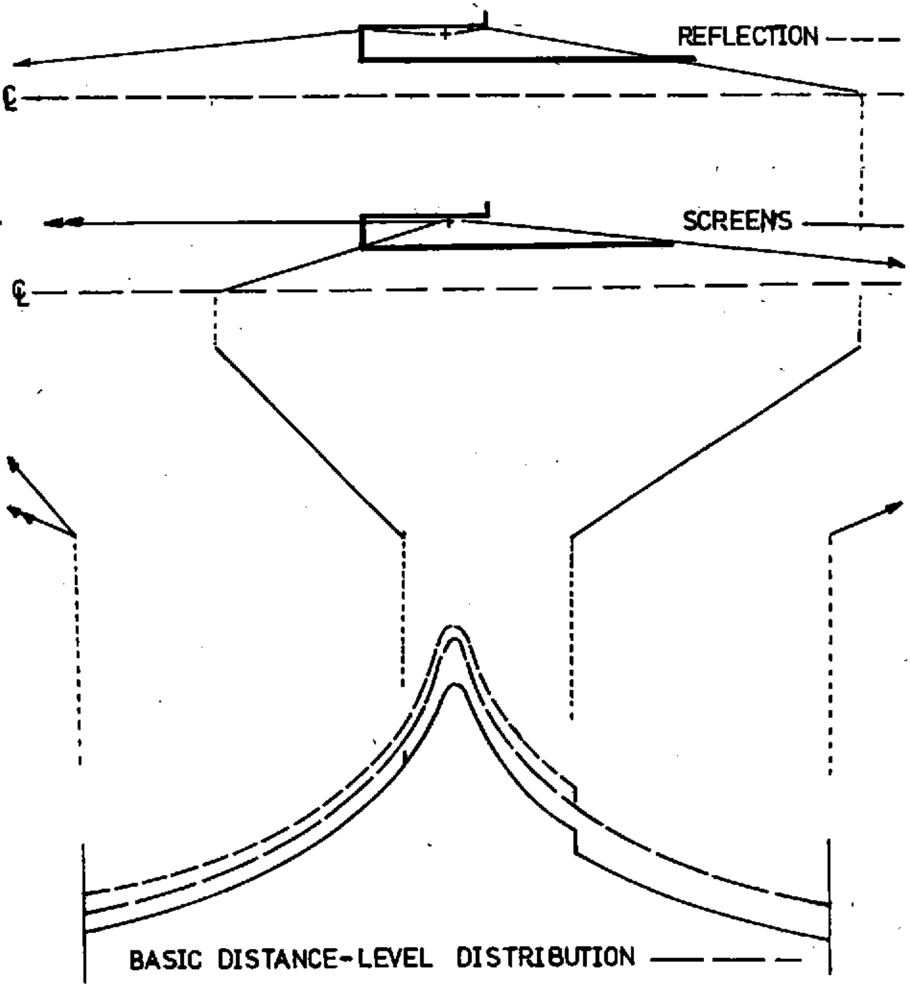



Figure 2 The effects of screens and reflectors on the individual vehicle distance - level noise distribution at position C.