inter•noise 96
25th Anniversary Congress – Liverpool

INCE: 76.1.1.1

APPLICABILITY OF 'CALCULATION OF ROAD TRAFFIC NOISE' FOR HIGH RISE RESIDENTIAL BUILDINGS IN HONG KONG

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1. INTRODUCTION

The 'Calculation of Road Traffic Noise' (CRTN) method [1], using a road segment angle approach, has been developed in U.K. where noise sensitive receivers are basically low rise. The road segment angle in the method is defined in a horizontal plane level with the road regardless of height of the reception point.

However, high-rise residential buildings (up to about 40 storeys) are common in Hong Kong. In some extreme cases, the actual road segment angles are much smaller than those defined in the horizontal planes. Use of the CRTN method might lead to an over-estimation of noise levels at the reception points in such cases.

This paper will give a brief discussion of the problem. In addition, a preliminary field study in Hong Kong will be presented. Results of the study will be compared with the CRTN prediction to determine whether further studies are recommended to conclude if a correction factor in the CRTN method, to allow for the actual road segment angle, is required for prediction of traffic noise level in the above extreme cases.

2. THE PROBLEM

Fig. 1. shows a reception point R and a road on the same level. R is at a distance d from the road and has a road segment angle θ limited by intervening obstacles. The road segment angle is reduced to θ' as the reception point moves horizontally to a greater distance d' from the road. The CRTN method allows for both the smaller θ' (correction = $10\log_{10}(\theta'/\theta)$) and the larger distance d' (correction = $10\log_{10}(d/d')$) in predicting the difference in noise levels at R and R'. For an elevated reception point R_h right above R, the road segment angle is reduced to θ_h but the CRTN method only allows for the larger distance d_h in predicting the noise level difference in this case.

In U.K. where noise sensitive receivers are basically low rise, difference between the road segment angle defined in the horizontal plane and the actual road segment angle is negligible even for a reception point at an upper floor. In Hong Kong, high rise residential buildings are common. The difference between the road segment angle θ defined in the horizontal plane and the actual road segment angle θ_h is significant in the extreme case that the reception point is located at an upper floor of a skyscraper which is close to the road, and has a small road segment angle. As the correction factor $10\log_{10}(\theta_h/\theta)$ for the much smaller θ_h is omitted in the CRTN method, use of the method for predicting the noise level at such a reception point might result in an over-estimation.

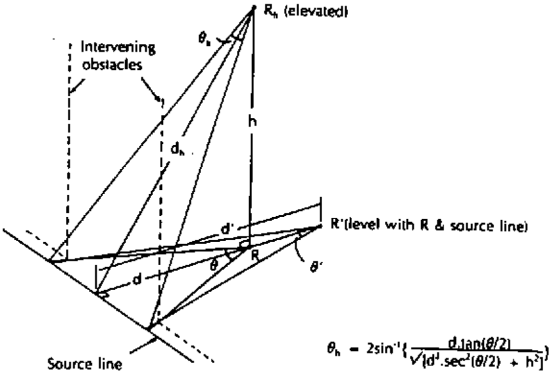

Fig. 1

3. THE FIELD SURVEY

The Site

Fig. 2. is a plan showing the configuration of the site. There was a two-lanes-two-ways road fronting a 37-storeys residential building. The highest floor was at about 100m above the road surface. Reception points were selected at same locations on different floors. Each reception point had a road segment angle (defined in the CRTN method) of only 40°. The horizontal distance between the reception points and the centre line of the road was 58m. Actual road segment angle changed from 39.1° at the lowest reception point (3/F.) to 20.4° at the highest reception point (36/F.)

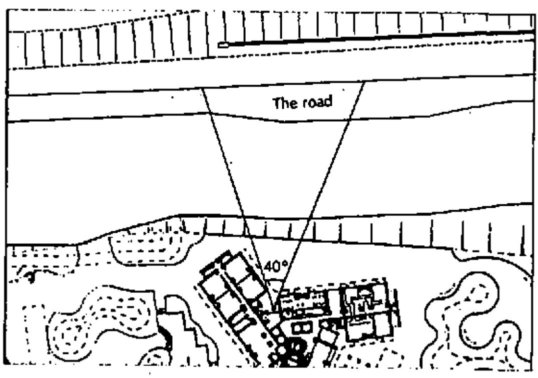

Fig. 2

Noise Measurement
The noise measurement was carried out with B&K 2231 sound level meters. Field calibration using B&K 4230 calibrator was carried out before and after the measurement.

Traffic Count
In addition to noise levels, the following data were also obtained in the site survey for determining the mean traffic speed, traffic volume, and percentage of heavy vehicles which were required for noise calculation:
(a) time taken for various types of vehicles travelling for a known distance;
(b) number of light vehicles and number of heavy vehicles in each direction during each noise measurement period.

Normalisation of Measured Noise Levels
For ease of comparison, the measured noise levels were corrected to allow for differences in traffic conditions in different measurement periods. By doing so, the corrected noise levels could be treated as results obtained in one measurement period and corresponding to one set of reference traffic conditions.

4. THE NOISE CALCULATION

Based on the reference traffic conditions, noise levels in L_{10} (1-hour) dB(A) were calculated at positions exactly the same as those of the noise measurement points.

5. THE COMPARISON

As can be seen from Table 1., difference in the measured noise levels at 3/F. & 36/F. was 5.9 dB(A). The calculated counterpart was only 2.8 dB(A). The larger measured difference might be due to an elevation dependent factor, i.e. the actual road segment angle, which was not allowed for in the calculation.

Table 1

Floor no.	Height above road (m)	Noise levels (L_{10} dB(A))	
		Measured (normalised)	Calculated
3	12.85	68.8	66.2
9	29.05	68.3	65.9
12	37.15	67.6	65.7
18	53.35	66.1	65.1
24	69.55	65.6	64.5
36	101.95	62.9	63.4

An attempt was made to explain the above by introducing corrections to allow for the actual road segment angles to the calculated noise levels. The corrections and a further comparison are shown in Table 2.

Table 2

Floor no.	Height above road (m)	Actual road segment angle, θ_h (deg.)	Corrections, $10\log(\theta_h/40)$ (dB(A))	Noise Levels	
				Calculated (corrected) (dB(A))	Measured (normalised) (dB(A))
3	12.85	39.1	-0.1	66.1	68.8
9	29.05	36.1	-0.5	65.4	68.3
12	37.15	34.1	-0.7	65.0	67.6
18	53.35	30.0	-1.3	63.8	66.1
24	69.55	26.2	-1.8	62.7	65.6
36	101.95	20.4	-2.9	60.5	62.9

6. DISCUSSION & RECOMMENDATION

It can be seen from Table 2. that with the corrections for the actual road segment angles, differences between the calculated noise levels and the measured noise levels (normalised) fall within a narrow range of 2.3 to 2.9 dB(A) and are comparable to the rms error (difference between measured and predicted noise levels) of 1.9 dB(A) reported by Abbott and Nelson [2] in U.K. The narrow range of differences is believed a result of some elevation independent factors such as traffic mix, road surface, and reflection effect of the building facades on the two sides of the measurement points. The more important observation is, however, that the difference in the calculated noise levels (corrected) at 3/F. & 36/F. is 5.6 dB(A) which agrees well with the measured difference of 5.9 dB(A). These results, though not conclusive in view of the small sample, give an initial indication that using the actual road segment angle in the calculation may give a better prediction for the extreme case of an elevated reception point which has a small angle of view on a road close to it.

It is recommended to obtain more data to enable a conclusion to be drawn.

References

[1] Department of Transport, Welsh Office, *Calculation* of Road Traffic Noise, HM Stationery Office (1988).

[2] P.G. Abbott and P.M. Nelson, The Revision of Calculation of Road Traffic Noise (1988), Acoustics Bulletin, Institute of Acoustics (January 1989).

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