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PREDICTION AND FIELD VALIDATION OF ROAD TRAFFIC NOISE

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1. INTRODUCTION

'Calculation of Road Traffic Noise' [1] is used in Hong Kong for highway design, land use planning, and assessing entitlement to sound insulation treatment of residential premises.

In accordance with 'Calculation of Road Traffic Noise', the flow of traffic in both directions shall be aggregated to obtain the total flow on normal roads, and the source of traffic is taken to be 3.5 metres in from the nearside carriageway edge. Only in cases where the two carriageways are separated by more than 5 metres or where the heights of the outer edges of the two carriageways differ by more than 1 metre, the noise level produced by each of the two carriageways shall be evaluated separately. In the case of the far carriageway the source line will be assumed to be 3.5 metres in from the far kerb.

For normal roads with two or more lanes for each traffic direction, the distance between the nearest lane and the farthest lane may be up to 21 metres (corresponds to four lanes for each direction), a single line on the nearside carriageway may oversimplify the traffic noise source. This paper describes an initial attempt to examine the appropriateness of single source line assumption in 'Calculation of Road Traffic Noise' for wide normal roads by comparing predicted noise levels based on single source line and separate source lines with data of measurement.

2. SITES SELECTED FOR COMPARISON PURPOSE

2.1 Site Selection Criteria

A proper site for the comparison purpose should satisfy the following conditions:

[a] the road should be normal as defined in 'Calculation of Road Traffic Noise' and has a wide spreading of flow of traffic across it such that there is a great deviation from the single source line assumption;
[b] the site geometry must be simple to reduce corrections and hence errors in noise prediction;
[c] the traffic should be free flowing since 'Calculation of Road Traffic Noise' does not allow for interrupted flow of traffic;
[d] the road should be the only (main) road in the area so that differences in predicted noise levels based on the two assumptions of source of traffic are not masked by noise contribution from other roads;
[e] there should be no other significant noise sources such that the measured noise levels are representative of road traffic noise.

2.2 Description of selected Sites

Two sites were selected for field measurement. In Site 1, there was a six-lane at grade highway separating a harbour and a vegetated area in the hinterland. The highway was paved with pervious material. There was no other noise source. As can be seen from Fig. 1, the highway was basically straight and was the only road in the area. Noise measurement was carried out on the vegetated area at different horizontal distances from the highway.

In Site 2, there was a six-lane elevated highway separating a harbour and buildings in the hinterland as shown in Fig. 2. Besides road traffic, there were other noise sources including aircraft during landing and taking-off on the other side of the harbour, and helicopters hovering above the harbour. Noise from aircraft and helicopters were edited out from the measurements. Noise from ferries was not prominant. Noise from the two slip roads was insignificant as verified by calculation. Noise measurements was taken at different height on the roof of a building adjoining the highway. The parapet wall on the roof of the building was taken as a barrier which was intentionally selected as a feature not found in Site 1.

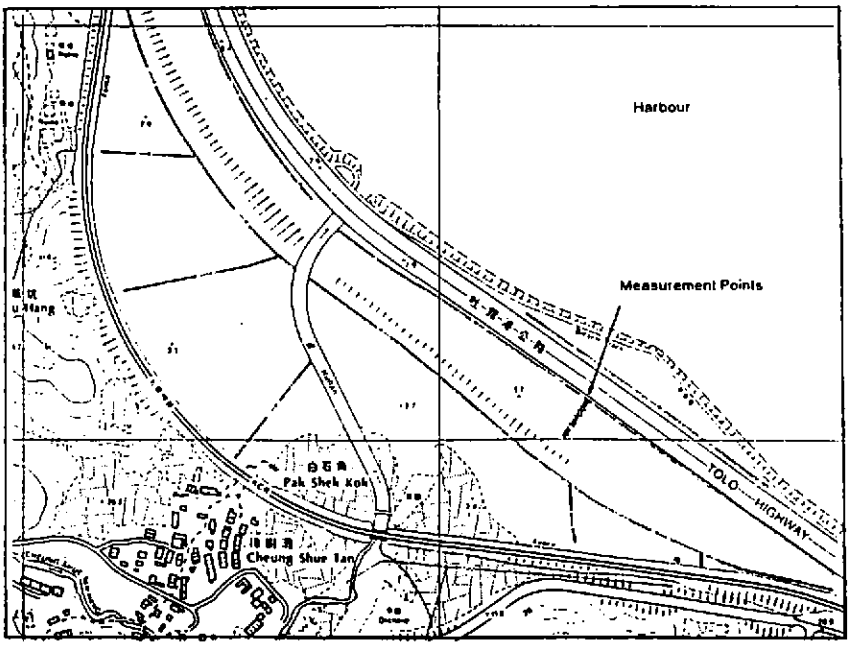

Fig. 1. Layout Plan of Site 1

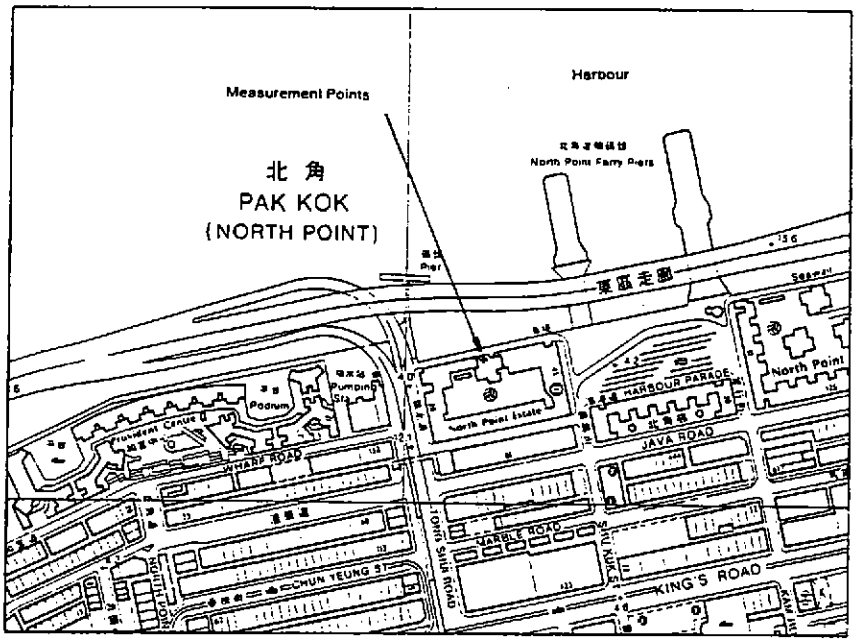

Fig. 2. Layout Plan of Site 2

3. NOISE CALCULATION

In Hong Kong, traffic noise is described in L_{10} (1-hour) dB(A). Noise levels in terms of this descriptor were calculated at positions same as those of the noise measurement points. Calculation was carried out for a single source line of traffic noise in accordance with 'Calculation of Road Traffic Noise', as well as for two source lines (one on nearside carriageway and one on farside carriageway) for comparison purpose. Traffic data obtained in the field measurements were used in the calculation.

4. SITE MEASUREMENT

4.1 Noise Measurement

Noise measurement was carried out with three sets of B&K 2231 sound level meters. Field calibration using B&K 4230 calibrators was carried out before and after the measurement. Traffic flows during measurements were fairly consistent in the selected sites. Measurements for periods of ten minutes which could be taken as hourly representatives were made. In each ten-minute measurement period, two to three measurements were made simultaneously at different positions in each site.

4.2 Traffic Data

In addition to noise levels, the following data were also taken in the site surveys:

[a] time taken for various types of vehicles travelled for a known distance;
[b] number of light vehicles in each direction during each noise measurement period;
[c] number of heavy vehicles in each direction during each noise measurement period.

The first set of data was used to obtain the mean traffic speed for the noise calculation. The numbers of vehicles were used to work out the hourly traffic flow and percentage of heavy vehicles during the measurement period. Table 1 shows the hourly traffic flow and percentage of heavy vehicles of the two sites.

Table 1: Traffic Data

Site	Measurement Period	Hourly Flow of Traffic (Veh/hr)		% of Heavy Vehicles	
		Nearside	Farside	Nearside	Farside
1	1	3348	3708	71.9	62.0
	2	3000	2784	66.6	55.2
	3	3042	3426	64.3	57.1
	4	2790	2520	69.0	57.1
2	1	4176	4104	35.8	37.1
	2	3570	4308	33.6	35.5
	3	3480	3906	25.0	31.0

5. NOISE MEASUREMENT AND PREDICTION RESULTS

Fig. 3 and Fig. 4 are the measured noise levels and the predicted noise levels at Site 1 and Site 2 respectively. Predicted noise levels were based on traffic data in Table 1 for each respective measurement period. Table 2 is a summary of of mean prediction error (predicted minus measured) and rms prediction error of noise levels associated with the two sites.

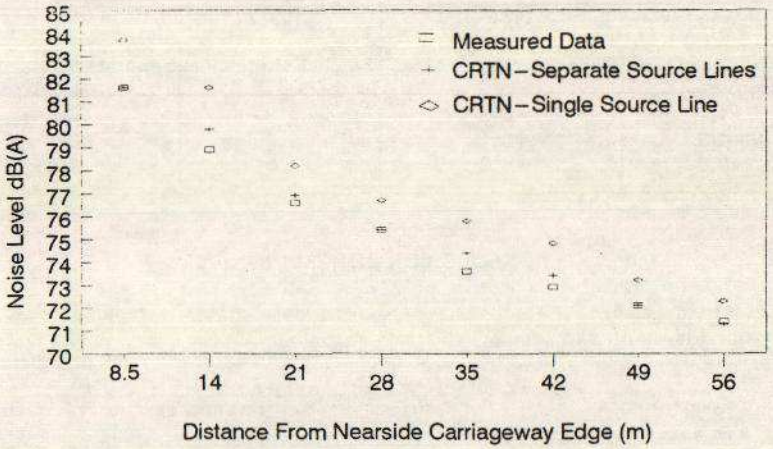

Fig. 3 Measured and Predicted Noise Levels at Site 1

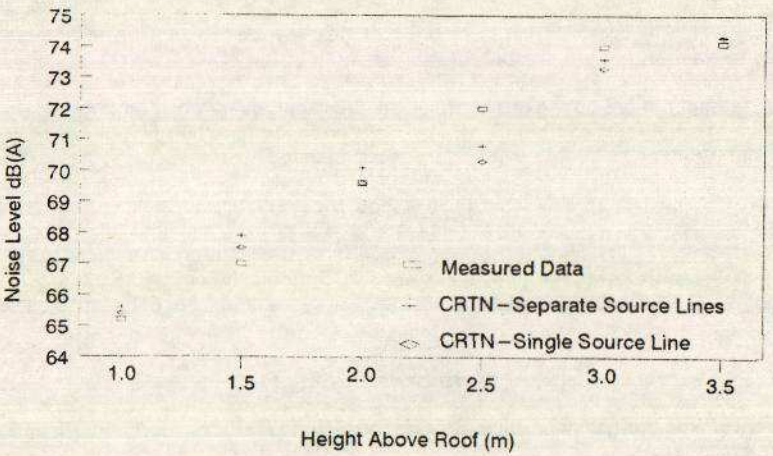

Fig. 4 Measured and Predicted Noise Levels at Site 2

Table 2: Mean Prediction Error and RMS Prediction Error

Site	Mean Prediction Error (dB(A))		RMS Prediction Error (dB(A))	
	Single Source Line	Separate Source Lines	Single Source Line	Separate Source Lines
1	+1.7	+0.3	1.8	0.5
2	-0.3	+0.1	0.8	0.7
1&2	+0.8	+0.2	1.5	0.6

6. DISCUSSION OF RESULTS

It can be seen from Table 2 that both single and separate source line assumptions give good prediction of noise levels. The rms prediction errors for a single source line assumption for the two sites in Hong Kong are comparable to the rms error of 1.9 dB(A) reported by Abbott and Nelson [2].

For Site 1, the considerably smaller prediction errors based on the separate source line assumption indicate that this assumption gives better prediction for this site. Indeed, this assumption gives consistently better prediction for this site as can be seen from Fig. 3.

For Site 2, magnitudes of differences in prediction errors similar to those for Site 1 was expected. Outcome of the study for Site 2 however shows that the differences are minute, though the prediction errors based on the separate source lines assumption are again the smaller, as in the case of Site 1.

The geometry of Site 2 was reviewed. It was found that the distance between the parapet wall and the road in the site was large when compared with the width of the road. As a result, differences in corrections for barrier effects based on the two assumptions of traffic noise source in calculation and hence the differences in prediction errors are small. Similar study for a site where there is a barrier close to a wide normal road and hence greater difference in prediction errors based on the two assumptions of traffic noise source is therefore recommended.

Taking into account all data obtained for the both sites, the prediction errors based on the separate source lines assumption are 0.6 dB(A) (mean) and 0.9 dB(A) (rms) less than the respective counterparts. These results, though not conclusive in view of the small sample, give an initial indication that a separate source line assumption in the calculation method will give a better prediction. When more data are available, similar analysis will enable a conclusion to be drawn.

7. REFERENCES

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

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