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Limit of predicted road noise emissions due to traffic constraints – part 2

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ABSTRACT

There is a limit to the number of vehicles that can travel on a road section per hour. Vehicle speed will decrease as the road becomes congested. In Queensland, road traffic noise emissions are based on the Calculation of Road Traffic Noise method (CoRTN). This method is dependent on both traffic volumes and speed, among other parameters, however in the current calculation method, speed is assumed to be constant. By incorporating the inherent traffic speed constraints a more accurate method of calculating the $L_{10,\ 1hr}$ is obtained.

INTRODUCTION

The paper entitled "Limit of predicted road noise emissions due to traffic constraints" [1] put forward a method for including the inherent traffic speed limitations into the CoRTN calculation method [2]. This paper compares the method put forward with some simultaneously measured traffic volumes and noise levels.

Brief Review

The document "Guide to Traffic Engineering Practice – Part 2: Road Capacity" (the Guide), published by Austroads [3], is part of a series that form the basis of road traffic modelling in Australia.

The Guide defines the speeds at which vehicles will travel under certain traffic volume conditions. Table 5.1 from the Guide are reproduced below in Table 1. The design speed is required to be 10km/hr greater than the posted speed. We will be considering a road with a posted speed of 100km/h so the relevant data from Table 1 is found in the column titled Design Speed 110km/hr.

Table 1: Reproduction of Table 5.1 from the Guide

Table 5.1 Level of Service Criteria for Basic Freeway Segments

Level of Service	Density	Design Speed 110 km/h			Design Speed 100 km/h			Design Speed 80 km/h		
	pc/km/lane	Speed[a] km/h	v/c[b]	MSF[c]	Speed km/h	v/c	MSF	Speed km/h	v/c	MSF
A	≤ 7.5	≥ 96	0.35	-	-	-	-	-	-	-
B	≤ 12.5	≥ 91	0.54	1,100	≥ 80	0.49	1,000	-	-	-
C	≤ 18.8	≥ 86	0.77	1,550	≥ 75	0.69	1,400	≥ 69	0.67	1,300
D	≤ 26.3	≥ 74	0.93	1,850	≥ 67	0.84	1,700	≤ 64	0.83	1,600
E	≤ 41.9	≥ 48	1.00	2,000	≥ 48	1.00	2,000	≥ 45	1.00	1,900
F	> 41.9	< 48	d	d	< 48	d	d	< 45	d	d

a. Average travel speed.
b. Volume/capacity ratio.
c. Maximum rate of service flow per lane under ideal conditions, rounded to the nearest 50pc/h/lane.
d. Highly variable.

Source : Adapted from TRB (1985) Table 3.1.

Source: (Austroads: 1999)
MSF = vehicles per hour past a point.

The first column of Table 1 uses a general descriptor "Level of service." For a detailed explanation refer to the Austroads document *Guide to Traffic Engineering Practice, Part 2.* A simple description of each level of service follows.

Level of service A is considered a free flowing road in which drivers are practically unaffected by other vehicles on the road.

Level of service B is considered a stable flowing road and drivers have considerable freedom within the traffic stream.

Level of service C is also a stable flow, however, speeds and maneuverability are limited and the 'comfort and convenience' of the road decreases significantly.

Level of service D is close to the breakdown of stable flow. Speed and manuverability are severely restricted.

Level of service E is unstable flow with no room to maneuver and a high restriction on speed.

Level of service F is a breakdown of flow causing stop-start traffic, queuing and delays.

Using the values presented in Table 1 we can derive an equation to calculate the speed of the traffic for a particular traffic volume. With a bit of exponential curve fitting we arrive at Equation 1:

$$v = a \times \exp(bx) + c \times \exp(dx) \qquad (1)$$

Where:

v = traffic speed

x = traffic volume

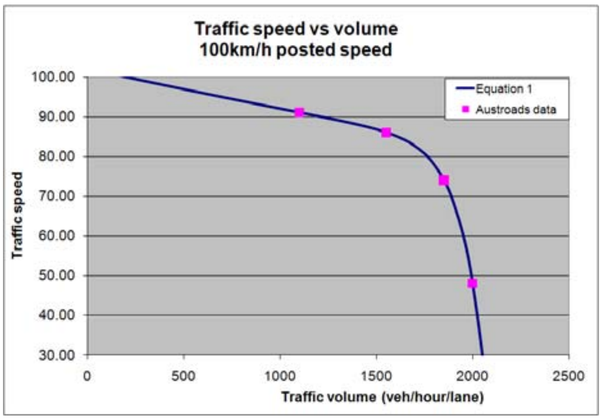
a = -2.665 E-06

b = 0.008194

c = 102

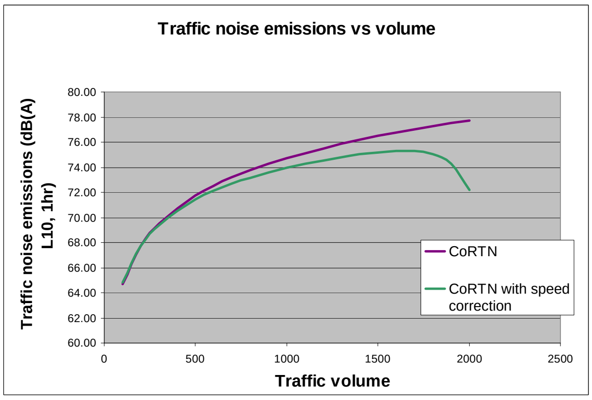
d = -0.0001036

Graph 1 below shows the accuracy of the equation



Graph 1: Comparison of Equation 1 and Austroads data

Using a reference distance of 10m, the 1 hour noise emissions based on the CoRTN method are shown in Graph 2 for the non-speed corrected, and speed corrected values for the range of traffic volumes.



Graph 2: Traffic noise emissions vs Traffic volume

From Graph 2, two observations can be made:

1. There is a greater difference between the speed corrected and the non-speed corrected noise emissions calculations at higher traffic volumes.

2. According to the speed corrected noise emissions calculation, there is a point at which increasing traffic volumes decreases the noise emissions.

MEASUREMENT INFORMATION

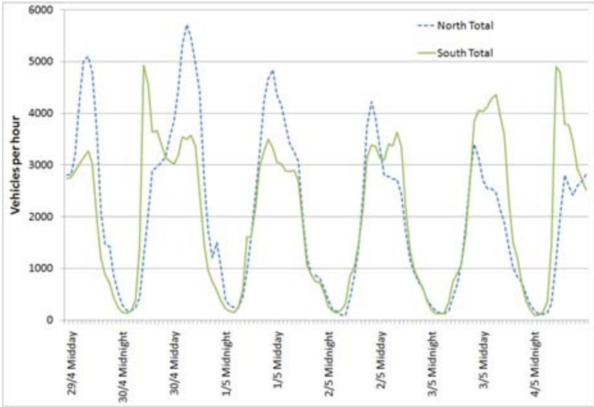
Simultaneous noise level and traffic volume measurements were undertaken 29 April – 4 May 2010 at the location shown in Image 1. The location is approximately 28 kilometres north of Brisbane, 13m from the nearest edge of the northbound carriage and 39m from the nearest edge of the southbound carriage. The posted speed is 100km/h and there are three lanes in each direction.

The noise logger was an ARL Ngara wave recording noise logger. The recorded wave files were reviewed and no additional noise sources were observed. There was slight precipitation on from the 29th April until 1pm 30th April and a large amount of precipitation on the 4th May from 4am.

Image 1: Noise logger location

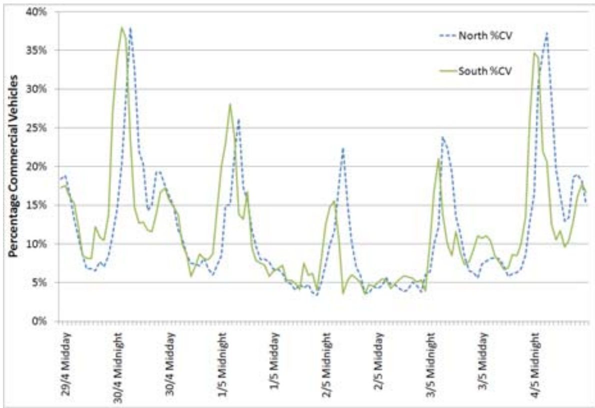
The traffic volumes were recorded by a permanent traffic counter on the same section of road slightly to the south of the logging location.

The traffic volumes observed during the monitoring period are shown in Graph 3.



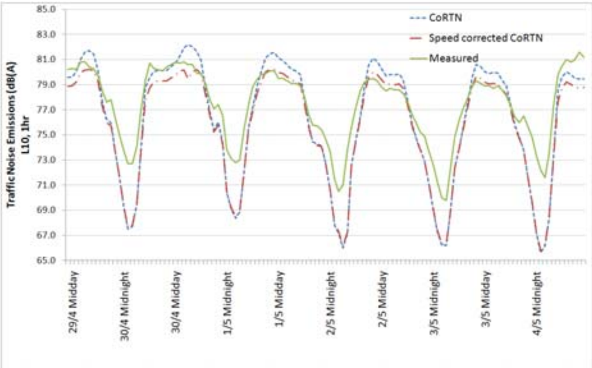
Graph 3: Traffic volumes during monitoring period

The percentages of commercial vehicles observed during the monitoring period are shown in Graph 4.



Graph 4: Percentage commercial vehicles during monitoring period

The road traffic noise emissions based on the traffic volumes and percentage of heavy vehichles were calculated according to the CoRTN method, and according to the proposed speed corrected method. The results, along with the measured noise levels are presented in Graph 5.



Graph 5: Calculated and measured noise levels

It can be seen that the proposed speed corrected method shows a much better correlation with the measured noise levels than does the non-speed corrected calculation.

It can be seen that the slight precipitation on the 29th and 30th April has increased the measured noise levels slightly, and that the heavy precipitation has greatly increased measured noise levels on the 4th May.

As expected, the predicted noise levels from the two calculation methods only differ where the traffic volumes are high. During the night periods, both methods predict the same hourly L_{10}.

CONCLUSIONS

The results of this study indicate that the proposed method shows better correlation with the measured noise levels. It is suggested that this method be included by the writers of legislation and road traffic noise codes of practice to improve the accuracy of their prediction methods.

REFERENCES

[1] Hall, B. 2009, *Limit of predicted road noise emissions due to traffic constraints*, Proceedings of AAS2009.

[2] Delany, M., Harland, D., Hood, R., and Scholes, W. 1976, *The prediction of road noise L_{10} due to road traffic,* Journal of Sound and Vibration, Wales.

[3] *Guide to Traffic Engineering Practice, Part 2 – Roadway Capacity*, 1999 Austroads, Sydney, Australia.

[4] Saunders, R., Samuels, S., Leach, R., and Hall, A. 1983, *An Evaluation of the U.K. DoE Traffic Noise Prediction Method,* Australian Road Research Board, Australia.