STANDARDS FOR MODELLING ROAD TRAFFIC NOISE IN WESTERN CANADA

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1 Introduction

A comparison was made between three road noise prediction standards: U.S. Department of Transportation Traffic Noise Model 3.0 (TNM), [1] and French standards NMPB 1996 [2] and NMPB 2008, [3][4] based on their ability to accurately predict the acoustical environment near Greater Vancouver highways. The comparison was made using post-construction noise monitoring performed by BKL staff and noise models that were developed by BKL staff for two large highway infrastructure projects near Vancouver, BC: the Port Mann Highway 1 Improvement (PMH1) Project and the Golden Ears Bridge (GEB) Project.

Both projects involved the construction of a multi lane bridge crossing the Fraser River, and the upgrading of highways and roadways on either side. BKL's scope on each project included extensive traffic noise modelling to predict post-construction conditions, and post-construction noise monitoring to confirm the accuracy of the predictions.

2 Method

2.1 Model Development

For the GEB project, a traffic noise model was developed using CadnaA® which included ground contours at 0.5 metre intervals, buildings, barriers, and highway traffic with 2-9% heavy trucks and posted highway speeds ranging from 60-100 km/h.

In a similar manner, a CadnaA® model was developed for the PMH1 project which included ground contours at varying intervals that were less than 0.5 metres, buildings, barriers, and highway traffic with 3-8.3% heavy trucks and highway speeds ranging from 70-100 km/h.

2.2 Measurement Procedure

Post-construction noise monitoring was performed at 15 and 80 locations along the extents of the GEB and PMH1 projects, respectively.

All monitoring was performed using sound level meters conforming to Type 1 specifications of American National Standard ANSI S1.4-1983 [5]. All measurements were taken in general accordance with the ISO 1996-2:2007 [6] and were clearly dominated by highway traffic noise.

2.3 Model Settings

Each CadnaA® model was developed using 3-D electronic files and drawings provided by the project highway engineers. Both models used baseline noise monitoring results for initial calibration. The post-project noise environment was predicted using highway traffic data (total volumes, vehicle classification and speeds) measured during the post-construction noise monitoring periods. The settings in Table 1 and Table 2 were applied or assumed for all predictions.

Table 1: General input parameters for CadnaA® road traffic noise modelling

Parameter	**Value**
General	
Max. Error (dB)	0.00
Max. Search Radius (m)	750-1000
Min. Dist Scr to Rcvr (m)	0.00
Digital Terrain Model	
Model of Terrain	Triangulation
Reflections	
Max. Order of Reflections	1-2
Projected Line Sources	On
Global Ground Absorption	1.0
Road Surface Ground Absorption	0.0

Table 2: Prediction standard specific input parameters for CadnaA® road traffic noise modelling

NMPB 1996 Specific Parameters	**Value**
Spectral Shape	2003/613/EC
Meteorology	Day: 50, Night: 100
Calculate Outer Lanes Separately	Enabled
NMPB 2008 Specific Parameters	**Value**
Calculate Outer Lanes Separately	Enabled
Meteorology	Day: 50, Night: 100
Calc Atalus	Enabled
Use Ch in Calculation of Abar	Enabled
TNM 3.0 Specific Parameters	**Value**
Truck Type	Heavy
Correct Bug in Fresnel-zone-calculation	Enabled

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2.4 Site Selection

Seven sites were selected to compare against the model predictions. Sites were selected where: the dominant noise sources were clearly apparent, the barrier attenuation was easy to define (e.g., no property line fences or other difficult-to-model objects), the measurement duration was at least 24 hours in duration, and where road traffic data specific to the site location was available. In addition, sites were excluded where there was the potential for significant attenuation from foliage due to the difficulty in accurately modelling excess attenuation due to heavy foliage.

All seven receivers had a 180 degree exposure to the highway, with setback distances ranging from 20-180 metres. Receivers were positioned at heights ranging from 1.5-2.8 metres above the ground, and the terrain between the highway and receiver was soft ground in all cases. One of the sites was on structure and four others had noise walls. Sites with modelled noise walls are shown with an asterisk in Table 3.

3 Results

Table 3 shows the average difference and the standard deviation of the differences for each prediction standard, along with the individual differences between predicted and monitored sound levels at each site.

Table 3: Calculated difference between predicted and measured sound levels (dBA) for three road traffic noise modelling standards

Site No. and Project	NMPB 1996	NMPB 2008	TNM 3.0
1 – GEB	-1.7	-3.9	-5.8
2 - GEB[1]	-1.9	-0.5	-2.9
3 - GEB[2]	-1.7	-0.6	0.6
4 - GEB	-1.0	-1.2	-4.5
1 – PMH1[1]	-1.6	-2.3	-6.6
2 – PMH1[1]	-0.8	-2.3	-3.6
3 – PMH1[1]	-0.8	-2.3	-3.8
Average Difference	-1.4	-1.9	-3.8
Standard Deviation of Difference	0.4	1.3	2.6

1– With 3 metre height noise wall, 2 – On structure with parapet

4 Discussion

All noise prediction standards under-predicted when compared with the sound levels that were measured. The road traffic noise model NMPB 1996 gave the most accurate results, with a maximum difference from the measured results of -1.9 dBA. Both NMPB models consistently under predicted for all sites. The TNM model was not consistent in its predictions, ranging from over predicting by 0.6 dBA to under predicting by -6.6 dBA. This is reflected in the large standard deviation of difference of 2.6 dBA.

The same set of calculations were repeated using the two NMPB standards, but changing the ground absorption setting for the road surfaces to non-reflective. The revised results were an average difference of -2.0 dBA and a standard deviation of differences of 0.5 dBA for NMPB 1996, and an average difference of -3.0 dBA and a standard deviation of differences of 1.3 dBA for NMPB 2008.

5 Conclusions

The accuracy of traffic noise modelling standards NMPB 1996, NMPB 2008 and TNM 3.0 were compared using post-construction measurements for two large highway infrastructure projects near Vancouver, BC, and the noise models developed for each. While all standards under-predicted traffic noise levels on average, the French standard NMPB 1996 yielded the most accurate results, with an average deviation of -1.4 dBA and a standard deviation of the differences of 0.4 dBA. The accuracy of the results was reduced if the road surfaces were not modelled as sound-reflective.

Although the TNM model was developed for North America, where traffic is more typical of that in BC as compared to traffic in France, the TNM model had poor results in comparison to the French road standards, for sites with and without noise walls.

References

[1] TNM-FHWA Federal Highway Administration Model, (http://www.trafficnoisemodel.org) TNM Version 2.5, McTransCenter University of Florida, 2088 Northeast Waldo Road, Gainesville, Fl 32609, http://mctrans.ce.ufl.edu

[2] NMPB-Routes-96. 1997. “Methode de calcul incluant les effets meteorologiques, version experimentale, Bruit des infrastructures routieres.” Lyon, Centre d’etudes sur les reseaux, les transports, l’urbanisme et les constructions publiques. Service d’etudes techniques des routes et autoroutes - Laboratoire central des ponts et chaussees - Centre scientifique et technique de batiment.

[3] NMPB-Routes-2008. 2009a. “Guide méthodologique, Prévision du bruit routier, Volume 1: Calcul des émissions sonores dues au trafic routier.” Référence Sétra: 0924-1. SETRA (Service d'études sur les transports, les routes et leurs aménagements).

[4] NMPB-Routes-2008. 2009b. “Methodological guide, Road noise prediction, volume 2: NMPB 2008 - Noise propagation computation including meteorological effects.” Référence: LRS 2008-76-069. SETRA (Service d'études sur les transports, les routes et leurs aménagements).

[5] American National Standards Institute (ANSI). 1983. “Specification for Sound Level Meters”. Reference No. ANSI / ASA S1.4-1983 (R2001). New York, Acoustical Society of America (ASA).

[6] International Organisation for Standardization (ISO). 1996. “Acoustics - Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation”. Reference No. ISO 9613-2:1996. Geneva, International Organisation for Standardization.