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DEVELOPMENT OF A MODEL TO PREDICT TRAFFIC NOISE (L_{10}) IN URBAN CENTERS: A COMPARISON WITH THE APPRAISED MODEL CRTN

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This papers aims to evalue the accuracy between the CRTN prediction traffic noise model and a model developed recently in Belo Horizonte, Brazil. The preliminary results show a good precision of both wuhen compared with real measured database.

1. Introduction

The Calculation of Road Traffic Noise – CRTN method, is an appraised model already being used worldwide to predict traffic noise, especially in highways and roads of urban centers. This model predicts the level L_{10} percentile and considers correction values due to several factors such as the percentage of trucks, the distance between source and receiver, sound reflections on the surfaces, sound propagation and phase speed [2].

Recently, a research on traffic noise prediction has been done in urban ways Belo Horizonte-MG, Brazil. Thus, the main goal of this work is to develop a statistical model for the prediction of noise levels (L_{10}) and to compare with the CRTN model. Some parameters considered on the formulation, for example the percentage of trucks and sound reflection, were adjusted for the testing and application of the CRTN model.

2. Methodology

In this topic are described the study area, the research methodologies used, model calibration and analysis of the results. Measurement of transport parameters were: road, count inventory classified vehicles, and one-off searches these speed which will be explained in detail below.

2.1 Study area

Point 1 is located on Avenida Silviano Brandão between the streets Capuraque and Pitangui, as shown in Figure 1. Point 2 is located on Avenida Silviano Brandão between Elói Mendes and alabaster streets, in front of the Hospital São Camilo, as shown in Figure 2.

Figure 1: Point 1 area

Figure 2:Point 2 area

2.2 Count classified of vehicle

This survey was done by two researchers with artboards 8 meters. It was considered 15min range and the two directions (Center-Neighborhood and Neighborhood-Center). Were considered the following vehicles:

1. Car;
2. Motorcycles;
3. Lightweight Truck;
4. Heavy Truck;
5. Minibus;
6. Buses Padron;
7. Articulated Buses.

2.3 Spot speed

Average speed search was done with a radar brand Bushnell pistol shaped that identifies the speed of the vehicle with an electromagnetic wave. All data obtained were in km/h and there was no division into types of vehicles.

Data collected were automatically tabulated, separated by direction towards, for every 15 minutes and by point. The data for each interval in each point were calculated the mean, median, fashion and the standard deviation, all in their definitions, statistics for later comparison in data analysis, if necessary.

3 Development of prediction model CRTN L10

The main objective of this section is to present the CRTN method. Although a brief description of the model is presented, a more detailed explanation can be found on the Department of Transport, Welsh Government [2]. The equation which predicts the parameter L_{10} percentile is given by:

$$L_{10} = 42{,}2 + 10 * \log_{10} q \tag{1}$$

Where:

L_{10} is the percentile level present in only 10% of the period in question;

q is the flow of the period studied.

For this case, the period considered was the interval of 15 minutes. According to CRTN manual, you must add the corrections concerning distance, heavy vehicles and reflections, when necessary to this equation. The equations 2, 3, 4 and 5 show the equations to obtain the value of fixes the distance and vehicle weighed.

$$p = 100 * \left(\frac{f}{q}\right) \tag{2}$$

$$cvp = 33 * \log_{10}\left[v + 40 + \left(\frac{500}{v}\right)\right] + 10 * \log_{10}\left[1 + \left(\frac{5*p}{v}\right)\right] - 68{,}8 \tag{3}$$

$$d' = \sqrt{h^2 + (d + 3{,}5)^2} \tag{4}$$

$$cd = 10 * \log_{10}\left(\frac{d'}{13{,}5}\right) \tag{5}$$

Where: p is the percentage of heavy vehicles;

f is the flow of heavy vehicles;

q is the total flow;

v is the average speed;

d is the distance between the source and receiver noise;

h is the vertical distance between the receiver and the source;

d is the horizontal distance between the receiver and the source;

cd is the corresponding distance correction.

In the case of this article, some considerations were done for the model CRTN. For distance correction, height of noise source was considered 0,35 m. On the two points of measurement noise the meter height was 1,20m. The distance was considered from the noise meter to the center of the avenue, ranging to each point. For correcting the heavy vehicles, those were considered only buses and trucks. About correction on the surface were added 1,5dB for each reflecting surface disregarding the floor. There is no ceiling on the measuring site and there are surfaces with openings. Table 1 shows all variables necessary to add to the model of CRTN.

Table 1: Values of the corrections to the prediction model of CRTN

cvp	cd
0,66	1,14
0,78	1,14
-0,01	1,14
1,10	1,14
0,18	1,14
0,64	1,14
-1,27	1,14
-1,17	1,14
-1,07	1,14
-0,98	1,14
-0,42	1,14
-0,43	1,14

Thus, the final model CRTN for this case is the sum of the equation 1 with the aforementioned corrections. The equation 6 demonstrates this conclusion.

$$L10 = 42{,}2 + 10 * \log_{10} q + cvp + cd + cr \quad (6)$$

4 Development of the Prediction Model (L_{10}) and comparison with the CRTN Model

For the development of a model for predicting noise levels (percentiles L_{10}) was used the theory of regression logarithmic [1]. In this model, presented in the equation 7, L_{10} was related to the Leq, sound pressure level equivalent.

$$L_{10} = 26{,}55542475 * (1{,}014355565^{Leq}) \quad (7)$$

r^2=0,87 t_{Leq}=8,55 t_b=26,34 t_{min}=2,23 F=73,12 F_{min}=4,96

where: L_{10} is the percentile noise level;
L_{eq} is the sound pressure level equivalent;
r^2 is the coefficient of determination;
t_{Leq} is the value of the t-student test for variable L_{eq};
t_b is the value of the t-student test for constant;
t_{min} is the minimum value for the t-student test;
F is the value of the f statistic;
F_{min} is the minimum value for the f statistic.

Comparing this prediction model with the model of CRTN developed the chart 1.

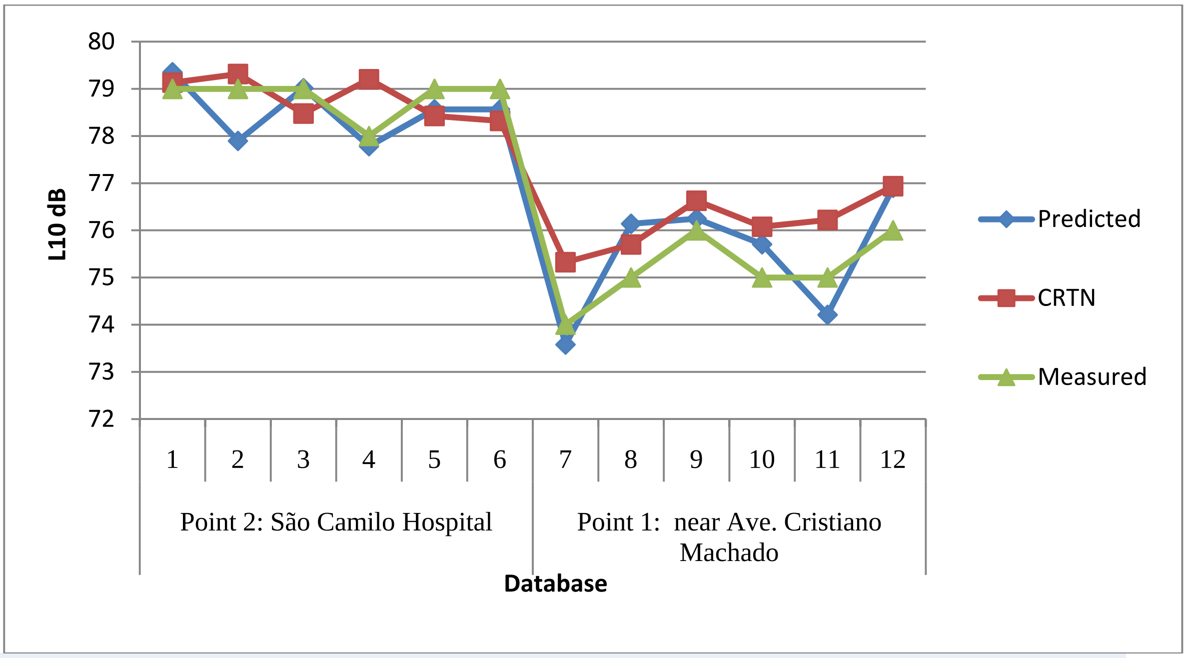

Figure 3: Comparison between the model predicted, the CRTN and the measured value

As can be noted in this chart, the model calibrated and the CRTN can be appropriate to predict the L_{10} in urban centers. When is verified the average error of the both models, the calibrated model show a smaller one (2,29 dB(A)) than the CRTN (2,96dB(A)). This can be justified this through considerations of CRTN Manual [2], being better recommendation to be used for measurements of L10 CRTN between 80dB and 85dB. Another consideration being made is that the CRTN model was based on a track with average speed of 75km/h, and larger than those presented in the samples in this study.

5 Conclusions

From the tab of the data, obtained in field applying methodologies correctly, it was possible to calibrate a prediction model L_{10} and compares it with the template CRTN. The both are accurate to be used, but the model calibrated show a better result.

Model calibrated shows on accuracy, so it can become a helper tool for obtaining the value of L_{10} in urban centers. However be overemphasized that model was based on a track with average speed of 75km/h, it is recommended to test it in other situations, including comparing their accuracy with other existing models, in order to obtain better results.

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