Comparison of Traffic Noise Predictive Models with Experimental Data in Varanasi City India

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Abstract:

Among the environmental pollutants, noise is considered to be a cause of the widespread occupational and community health problems and consistently ranks high on the list of citizens' concerns. There are many sources of noise, but one of them clearly dominates: road traffic noise the impact of road traffic noise, which has far-reaching and wide-ranging effects, has increased because of industrialization and urbanization resulting in an increase in noise levels. Thus, road traffic noise has become an issue of immediate concern to many authorities. Road traffic noise as one of the main sources of environmental pollution has led to develop models. The road traffic noise control is often performed by means of Traffic Noise predictive Models (TNMs). In this paper, summarized some of the most known Traffic Noise predictive models, a comparison between simulated and experimental data is performed, in order to highlight the behavior of models in ten different sites.

Key-Words: - *Noise Control, Road Traffic Noise, Traffic Noise Models, Urbanization*

1. Introduction

Noise is a recognized and a ubiquitous environmental pollutant that can cause a wide range of negative social impacts, it leads to annoyance, reduces environmental quality, and might affect health and cognition. Noise can be defined as the level of sound which exceeds the acceptable level and creates annoyance. The major sources of noise are Industrial noise, Traffic noise & Community noise. Traffic noise is one of the significant sources of the noise compared to the other sources [1-4].

Unfortunately, road traffic has become a serious problem in many countries, and it is difficult to regulate by physical means alone. Investigations in different countries in the past several decades have shown that noise affect different activities badly and cause sleep disturbances and a poorer life quality. Road traffic noise is the worst in this category because it is more or less a continuous sound which fluctuates from hour to hour in a more or less irregular fashion with the passage of individual vehicles. Therefore, there is an essential need to control the noise induced by road traffic.

In this framework, the development and the utilization of a suitable mathematical predictive model, i.e. a Traffic Noise Model (TNM), is quite relevant in order to perform an estimation of noise emitted in the environment, even without the aid of experimental measurements. This issue can be of fundamental importance when a new infrastructure has to be settled down, that is in a preliminary planning program, or when a road is already "in operam", in order to monitor the noise impact on the surrounding environment just by knowledge of few traffic and road parameters.

2. Review of some Traffic Noise Models

In this section, some of the most used TNMs, in particular the ones used in the comparison, are briefly sketched. In all the formulas, Leq is the equivalent noise level, Q is the vehicles flow, P is the percentage of heavy vehicles, d is the distance source-receiver.

2.1. Burgess Model [5]

$$L_{eq} = 55.5 + 10.2Log(Q) + 0.3P + 19.3Log(d)$$

One of the most used is the Burgess Model applied for the first time in Sydney in Australia.

2.2. Griffith and Langdon Model [6]

$$L_{eq} = L_{50} + 0.018(L_{10} - L_{90})^2$$

Where the statistical percentile indicator are evaluated with the following formulas:

$$L_{10} = 61 + 8.4Log(Q) + 0.15P - 11.5Log(d)$$

$$L_{50} = 44.8 + 10.8Log(Q) + 0.12P - 9.6Log(d)$$

$$L_{90} = 39.1 + 10.5Log(Q) + 0.06P - 9.3Log(d)$$

2.3. CSTB Model [6]

$$L_{eq} = 0.65L_{50} + 28.8\ [dBA]$$

The value of L50 is calculated taking into account only the equivalent vehicular flows (Qeq), and is given by:

$$L_{50} = 11.9Log(Q) + 31.4[dBA]$$

for urban road and highway with vehicular flows lower than 1000 vehicles/hour;

$$L_{50} = 15.5Log(Q) - 10LogL + 36\ [dBA]$$

for urban road with elevated buildings near the carriageway edge, with L the width (in meters) of the road near the measurement point.

2.4. FHWA (Federal Highway Administration Agency) model [7]

Traffic noise levels near roadways can be predicted based on individual vehicle noise levels, vehicle volume and speed, observer distance and other correlations. Traffic noise prediction algorithm is of the form given below:

$$L_{eq} = L_o + \Delta Li$$

Where: L_o – basic noise level of a stream of vehicles;

ΔLi – adjustment applied.

The basic noise level is the noise emitted by a particular class of the vehicle at a distance of 15 m from the centre of the inner lane at the given speed and for the given road surface. FHWA model calculates noise level through a series of adjustments to the reference sound level measured through field measurements. L_{eq} calculated using the following formula.

$$L_{eq}(h)_i = (L_o)E_i + 10\ 1og\left(\frac{N_i D_o}{S_i}\right) + 10\log\left[\frac{D_o}{R_n} - \frac{D_o}{R_f}\right] - 30$$

Where

$L_{eq}(h)_i$ = is the hourly equivalent sound level of the ith class of vehicle

$(L_o)E_i$ = is the reference energy mean emission level of ith class of vehicle

N_i = is the no of vehicles in the ith class passing a specified point during some specified time

D_o= is the refernce distance at which the emission levels are measured. In FHWA model, D_o is 15 meters

S_i = is the average speed of ith class vehicle and is measured in kilometers/ hour

T = is the time period over which the equivalent sound level computed

R_n = is the distance in meters between the centerline of the near end of the roadway segment and the observer

R_f = is the distance in meters between the centerline of the far end of the roadway segment and the observer

3. Field study

A study was carried out to compare the Noise prediction models with experimental data. Ambient noise levels were measured at different locations selected on the basis of traffic jams. This study was mainly intended to measure the noise level in urban locations.

Location	Location
Ravidas Gate	Cantt.
Rathyatra	Manduadi
Godowalia	Maidagin
Girijaghar	Andhra Pool
Saajan	Maldahiya

Keeping in view the objective of the study, a field data was collected. Geometric parameters like road width, the number of lanes, and lane width were measured. Longitudinal section parameter like the distance of a receptor point from the intersection was measured.

Classified traffic speed: The classified traffic speed was measured at each of the selected locations. The classified traffic speed study was carried out for the same duration as the noise level study and the traffic volume study. The speed was calculated using this formula.

$$q = KV_s$$

Where q = the average volume of vehicles passing a point during a specified period of timr (vehicles/hour)

K = the average density or number of vehicles occupying a unit length of roadway at a given instant (vehicles/ km)

V_s = space mean speed of vehicles (kmph)

Ambient noise level: Ambient noise levels for the selected locations were collected using the noise level meter. Ambient noise pollution data was collected continuously for a period of 10 min at all identified locations.

Traffic volume: As the directional classified traffic volume is the basic data requirement of this study, traffic volume studies were carried out at all locations identified for the detailed study. At all selected locations, traffic volume studies were conducted continuously for a period of 10 min.

4. Results and Discussions

In this section, a quantitative comparison between TNMs and experimental data is performed. From the figure 1 it was observed that FHWA model data and experimental data were almost same. From figure 2 it was observed that FHWA model was good fitted to traffic jam conditions in Varanasi city.

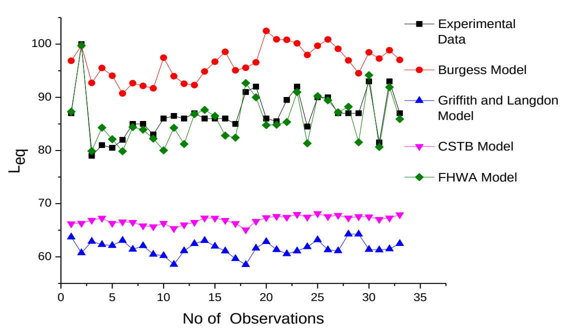

Figure 1: Comparison of L_{eq} values

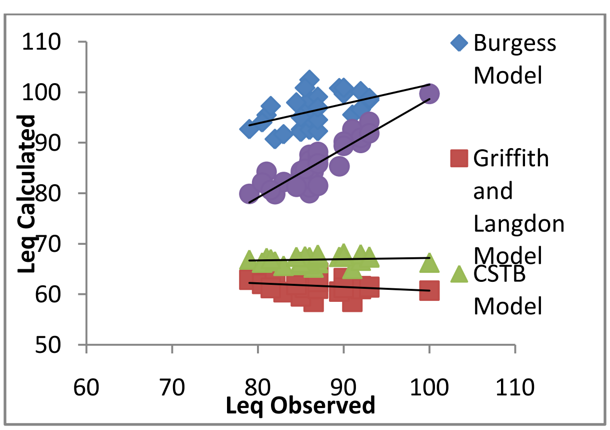

Figure 2: Comparison of Leq (observed) and Leq (calculated)

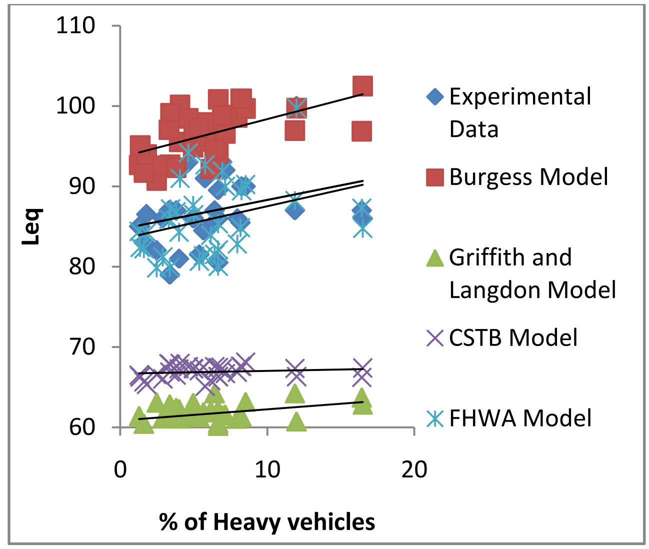

Figure 3: Comparison Leq values with % of heavy vehicles

5. Conclusions

In this paper the review of models presented by some of the authors has been extended to experimental measurements comparison. FHWA model is best suitable to traffic jam data compared to other model. Burgess model, Griffith and Langdon models and CSTB models were not suitable to present traffic conditions.

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