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International Journal OF Engineering Sciences & Management Research

MODEL FORMULATION OF TRAFFIC NOISE AT EXPRESS HIGHWAY

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Keywords: Noise Control, Traffic Noise, Vehicles Flow, Predictive Models.

ABSTRACT
The traffic noise produced by motor vehicles, as main sources in urban areas, is part of general environment problem which inflicts a serious damage to the health of human beings and lowers the labour productivity. In order to control acoustical sound level in urban areas, methods for prediction of the traffic noise are necessary, In this paper, we present the various predictive models, Griffith and Langdon noise model, Burgess traffic noise model, Centre Scientifique et Technique du Batiment (C.S.T.B.).

INTRODUCTION
The purpose of this study is to provide a model and methodology for estimating the impact of highway traffic on noise levels. The purpose of this research is to develop a predictive model for estimating sound levels from a highway traffic source for a future highway. Noise propagation as it relates to traffic volume has been the subject of a number of studies. Various approaches have been taken to examine how traffic impacts the transmission of noise in adjacent areas. Some models deal more with the calculation of traffic noise as it relates to the volume of traffic. Other models have looked at how spatial features influenced traffic noise impacts locations. Several studies have also examined how barriers, such as building impact noise.[Sean Michael Kelly, A model for predicting highway noise using a geographic information system: interstate 73 in guilford county, north carolina,2013,pp no.1-13.]

MATERIALS AND METHODS
The major part of the research topic. Five points where selected in order to establish the observation station. In Amravati city (maharashtra),At front of Hotel Gauri Inn (Location Code-01), At MIDC Crossing (Location Code-02), At Kondeshwar Crossing (Location Code-03), In front of PRMITR, Badnera (Location Code-04), At Badnera Highway (Location Code-05). In the present study, a noise sample size of 5 minute in each hour at a particular selected distance from the edge of the pavement was taken.

EXPERIMENTAL INVESTIGATION
Noise sample were collected in dB (A) scale at every 60 second interval or total 5 reading in one sample size. Also, the traffic volume survey was also carried out during the observation. The number of vehicle passing through the observation station where counted for 5 minutes duration in an Hour. The vehicles were divided into the sub categories such as 2 wheelers, 3 wheelers and 4 wheelers (light and heavy). The observation readings are taken at a distance 2.2 meter from the edge of road and at right angle to the centerline of road. Each location was observed for a week during the study.

ANALYSIS
1 NOISE PARAMETERS
1.1 The equivalent continuous sound level (Leq)
The equivalent continuous sound level has been adopted in a number of countries as means of measuring and assessing noise. It is sometimes referred to by various other terms than equivalent continuous sound level, such as mean energy level and equivalent sound level. The equivalent continuous sound level is given by the level of sound noise that has the same energy as the actual time varying noise in question.

1.2 Noise pollution level (LNP)
Noise pollution level specifically devised to take account of more complex time varying noises. The scale takes account of the equivalent continuous sound level over a particular period of time together with the variability of the noise environment. LNP is significant because in principle, it accounts for annoyance from aircraft, traffic and other sources such as industrial noise. Maximum permissible outdoor value of LNP is 88 dB(A)

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1.3 Traffic noise index

It coorelates with dissatisfaction towards traffic noise expressed by people. The measurement of TNI is difficult because of uncertainty arising from background noise coming from sources other than traffic on the road being considered. Prediction is also because of problem in predicting the background noise at large distance from the road.

1.4 Noise Climate (NC)

It is range over which the sound levels are fluctuating in an interval of time.

1.5 Equivalent noise levels (Leq)

Leq represents the equivalent energy sound level of a steady state and invariable sound. It includes both intensity and length of all sounds occurring during a given period. The noise levels of different squares in different time intervals were calculated along with their equivalent noise levels (Leq). The value of Leq in dB (A) unit was calculated by using the formula of Robinson, 1971, i.e.,

$$Leq = L50 + (L10-L90)2 / 56$$

where,

L10 : The level that were exceeded during 10% of the measuring time in dB(A).
L50 : The level that were exceeded during 50% of the measuring time in dB(A).
L90 : The level that were exceeded during 90% of the measuring time in dB(A).

1.6 Noise Pollution Level (NPL)

As Leq is an insufficient descriptor of the annoyance caused by fluctuating noise (Robinson, 1971), noise pollution level (NPL) expressed in dB was calculated by using the following formula:

$$NPL = Leq + a\,(L10-L90)$$

where,

a = 1.0 (constant in the equation).

NPL takes into account the variations in the sound signal and hence serves as better indicator of the pollution in the environment for physiological and psychological disturbance of the human system.

1.7 Traffic noise index (TNI)

Traffic noise index (TNI) is another parameter, which indicates the degree of variation in a traffic flow. This is also expressed in dB (A) and can be computed using the following relation:

$$TNI = 4\,(L10-L90) + L90 - 30 \text{ dB (A)}$$

1.8 Noise climate NC

Noise climate (NC) is the range over which the sound levels are fluctuating in an interval of time and was assessed using the following formula:

$$NC = (L10-L90)$$

Where, L90, the level exceeded for 90 % of the time of record, is very near to the background noise level in the absence of any motor vehicle traffic.

1.9 Traffic volume (Q)

The noise level near the highway depends on the number of vehicles. The noise level increases with an increase in traffic volume. Traffic volume is defined as the total number of vehicles flowing per hour. The number of vehicles passing through a fixed point on the road was counted. [BIJAY KUMAR SWAIN , SHREERUP GOSWAMI and SANTOSH KUMAR PANDA, Road Traffic Noise Assessment and Modeling in Bhubaneswar, India: A Comparative and Comprehensive Monitoring Study,international journal of earth science and engineering,2012,Pg No.1358-1370.]

From above formulae the different value is calculated which is given below as:

It was found that at location 01, the average of noise level (Leq) was found to be 76.6 dB(A). The average of L10, L50, L90, TNI, LNP, NC, Lmax, and Lmin values were found to be 85.0 dB(A), 76.0 dB(A), 67.0 dB(A), 109.0 dB(A), 94.6 dB(A), 18.00 dB(A), 99.9 dB(A),and 64.7 dB(A), respectively. It has been found that at location 02, the average of noise level (Leq) was found to be 75.6 dB(A). The average of L10, L50, L90, TNI, LNP, NC, Lmax, and Lmin values were found to be 83.0 dB(A), 75.0 dB(A), 65.0 dB(A), 107.0 dB(A), 93.6 dB(A), 18.00 dB(A), 99.8 dB(A),and 64.5 dB(A), respectively

It has been found that at location 03, the average of noise level (Leq) was found to be 81.4 dB(A). The average of L10, L50, L90, TNI, LNP, NC, Lmax, and Lmin values were found to be 86.0 dB(A), 81.0 dB(A), 75.0 dB(A), 89.0 dB(A), 92.4 dB(A), 11.00 dB(A), 94.8 dB(A),and 70.9 dB(A), respectively.

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It has been found that at location 04, the average of noise level (Leq) was found to be 75.6 dB(A). The average of L10, L50, L90, TNI, LNP, NC, Lmax, and Lmin values were found to be 83.0 dB(A), 75.0 dB(A), 67.0 dB(A), 101.0 dB(A), 91.6 dB(A), 16.00 dB(A), 90.2 dB(A),and 64.3 dB(A), respectively.
It has been found that at location 05, the average of noise level (Leq) was found to be 71.4 dB(A). The average of L10, L50, L90, TNI, LNP, NC, Lmax, and Lmin values were found to be 78.0 dB(A), 71.0 dB(A), 66.0 dB(A), 84.0 dB(A), 83.4 dB(A), 12.00 dB(A), 89.5 dB(A),and 65.2 dB(A), respectively.

2. MODELING USED TO PREDICT NOISE LEVEL:

2.1.Griffith and Langdon noise model

The prediction of noise level was computed by using the formula of Griffith and Langdon (1968), i.e., Leq = L50 + 0.018 (L10 – L90)2

where, the statistical percentile indicator was calculated with the following formulas:

L10 = 61 + 8.4 Log (Q) + 0.15P – 11.5 Log (d)
L50 = 44.8 + 10.8 Log (Q) + 0.12P – 9.6 Log (d)
L90 = 39.1 + 10.5 Log (Q) + 0.06P – 9.3 Log (d);

where, ‘Q’ is the vehicles flow, ‘P’ is the percentage of heavy vehicles and ‘d’ is the distance (2.2 m) of source receiver.[Bijay Kumar Swain,shreerup goswami and santosh kumar panda, Road Traffic Noise Assessment and Modeling in Bhubaneswar,India: A Comparative and Comprehensive Monitoring Study,2012,International journal of earth science and engineeriong,ISSN 0974-5904,Volume 05, No. 05(01).Pp No.1358-1370].

It was found that at location 01, the average of noise level (Leq) was found to be 83.4 dB(A). The average of L10, L50, L90, values were found to be 78.04 dB(A),75.80dB(A),57.43dB(A)

It was found that at location 02, the average of noise level (Leq) was found to be 74.07 dB(A). The average of L10, L50, L90, values were found to be 78.42 dB(A),65.62dB(A),56.75dB(A)

It was found that at location 03, the average of noise level (Leq) was found to be 72.27 dB(A). The average of L10, L50, L90, values were found to be 77.06 dB(A),64.84dB(A),56.74dB(A)
It was found that at location 04, the average of noise level (Leq) was found to be 72.94 dB(A). The average of L10, L50, L90, values were found to be 77.72 dB(A),65.89dB(A),57.92dB(A)
It was found that at location 05, the average of noise level (Leq) was found to be 73.26 dB(A). The L10, L50, L90, values were found to be 77.82 dB(A),65.29dB(A),56.77dB(A)

2.2.Burgess Traffic Noise Model

The prediction of equivalent noise level (Leq) was computedvby using the following formula of Burgess (1977):

Leq = 55.5 + 10.2 log (Q) + 0.3P – 19.3 log (d)

where, ‘Q’ is the vehicles flow, ‘P’ is the percentage of heavy vehicles and ‘d’ is the distance (2.2 m) of source receiver. [Akula Chandra Pradhan, 2012,“Measurements and model calibration of traffic noise Pollution of an industrial and intermediate city of india”,The Ecoscan: Vol.1,Page No. 379.]
It was found that at location 01, the average of noise level (Leq) was found to be 78.73 dB(A).
It was found that at location 02, the average of noise level (Leq) was found to be 80.24 dB(A).
It was found that at location 03, the average of noise level (Leq) was found to be 78.38 dB(A).
It was found that at location 04, the average of noise level (Leq) was found to be 77.52 dB(A).
It was found that at location 05, the average of noise level (Leq) was found to be 78.82 dB(A).

2.3.Centre Scientifique et Technique du Batiment (C.S.T.B.)

Another model was formulated by the French “Centre Scientifique et Technique du Batiment” (C.S.T.B.) which proposed a predictive formula of equivalent emission level, based on the average acoustic level (L_{50}) with the following expression:

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

The value of L_{50} is calculated taking into account only the equivalent vehicular flows (Q_{eq}), and is given by:

$$L_{50} = 11.9 \; LogQ \; 31.4 \; [dBA]$$

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

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$$L_{50}= 15.5\ LogQ\ 10\ LogL\ 36\ [dBA]$$

for urban road with elevated buildings near the carriageway edge, with L the width (in meters) of the road near the measurement point.[J. Quartieri, N. E. Mastorakis+, G. Iannone, C. Guarnaccia,S. D'Ambrosio, A. Troisi, TLL Lenza,A Review of traffic noise predictive models,recent advances in applied and theoretical mechanics,ISSN: 1709-2769,pp no.73]

It was found that at location 01, noise level (Leq) was found to be 63.41 dB(A). The L50 values were found to be 53.26dB(A).
It was found that at location 02, noise level (Leq) was found to be 62.52 dB(A). The L50 values were found to be 51.89dB(A).
It was found that at location 03, noise level (Leq) was found to be 63.10 dB(A). The L50 values were found to be 52.77dB(A).
It was found that at location 04, noise level (Leq) was found to be 64.09 dB(A). The L50 values were found to be 54.30dB(A).
It was found that at location 05, noise level (Leq) was found to be 62.80 dB(A). The L50 values were found to be 52.31dB(A).

Table No.1: Average vehicle flow and Percentage of Vehicle Flow

Sr. No.	Location	Avg. vehicle flow (Q)	Heavy Vehicle flow(%)
1	Hotel Gauri Inn	68.83	37
2	MIDC Crossing	52.75	45.95
3	Kondeshwar Crosing	62.58	32.75
4	Front of PEMITR, Badnera	84.08	30
5	At Badnera Highway	75.25	40

3.Model Predictions

The three models described - the Burgess Traffic Noise Model and the Griffith Prediction Noise Model and CSBT Noise model, were employed to predict the level of generated traffic noise at a number of study roadway locations. The result of predictions by the Griffith Prediction Noise Model and the Bergess Traffic Noise model and CSBT Noise model for the peak hour noise, along with the actual measurements of traffic noise at selected roadway sites are presented in

Table No.2: Measured and predicted equivalent noise level (Leq) at different location

Sr No.	Location	Measured Noise Level(Leq) dBA	Burgess Predicted (Leq) dBA	Difference Measured Vs. Burgess	Griffith Predicted (Leq) dBA	Difference Measured Vs. Griffith	CSBT Predicted (Leq) dBA	Difference Measured Vs. CSBT
1	Hotel Gauri Inn	76.6	78.7	+2.1	83.4	+6.8	63.41	-13.19
2	MIDC Crossing	75.6	80.2	+4.6	74.0	-1.6	62.52	-13.98
3	Kondeshwar Crossing	81.4	78.3	-3.1	72.2	-1.9	63.10	-18.3
4	Front of PRMITR, Badnera	75.6	77.5	+1.9	72.9	-2.7	64.05	-11.55
5	At Badnera Highway	71.4	78.8	+7.1	73.2	+1.8	62.80	-8.6

An examination of the data in Table reveals that:

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a) The Burgess Traffic Noise model consistently overestimates the generated noise in nearly all roadway sites (with one exception: Kondeshwar Crossing)
b)The Griffith prediction model generally overestimates the traffic noise at Location 1& 5 and underestimated at Location 2,3 & 4.
c) The CSBT prediction model generally underestimated the traffic noise at all location. **CONCLUSION**
The present study explicitly revealed that the noise levels are more than the permissible limit in all the investigated sites. Moreover, it clearly depicts that the transportation sector is one of the major contributors to noise in this city. Such noise measurements and questionnaire survey could be helpful in understanding the problem of noise pollution and contribute to improve city administration in abatement of noise pollution. Sustainable road traffic management must be introduced in such megacities considering elements such as road surface, tyres, traffic management, driving behaviour, noise barriers and city planning. Identification of noise reduction potentials considering all aforesaid parameters is the need of the hour.

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