A Study of Noise Pollution in Some Highway Corridor Near Gorakhpur City

Praveen Kumar
Department of Civil Engineering.
Madan Mohan Malviya University of Technology
Gorakhpur, India

Dr. Arun Kumar Mishra
Department of Civil Engineering
Madan Mohan Malviya University of Technology
Gorakhpur, India

Dr. Govind Pandey
Department of Civil Engineering
Madan Mohan Malviya University of Technology
Gorakhpur, India

***Abstract*—In the past few decades, traffic noise along highways has emerged as point of concern for the community residing in the nearby area. Roads are considered to be the arteries of the nation and, therefore, their development is to be taken up on high priority. At the same time, the increasing trend of traffic noise along the highways has necessity to the assessment of noise and traffic planning based on appropriate predictive approaches. The assessment of traffic noise is also important from the point of view of looking into noise exposed to the population and the adverse effect on the human health related therewith. In the present paper, the traffic noise along highway corridors on National Highways (NH–28, NH-29) and State Highways (SH-01, SH-81) passing near Gorakhpur city, has been observed at 12 sampling stations, 3 on each highway with the help of a sound level meter (Make Bruel and Kjaer - 2232) and the energy equivalent noise levels have been calculated. The traffic noise prediction is done with the help of Federal Highway Administration (FHWA) model using the traffic volume and speed data recorded at different sampling stations, namely "Army Public School, Padleygunj Chauraha, and Transport Nagar" on NH-28, "Nausad Chauraha, Mahabir Chhapra, and Belipar" on NH-29, "Chauri Chaura, Motiram Adda, and Kunraghat" on SH-01, "Asuran Chauraha, BRD Medical College, and Gularahia" on SH-81. The percentage error between the observed and the predicted values of energy equivalent noise levels is calculated. The agreement diagram is plotted between the observed and predicted values for the data pertaining to National Highways and State Highways separately. It is revealed that the noise levels predicted by FHWA model lie within an error band of ± 20% with reference to the observed noise levels. Thus, it is indicated that FHWA model can be used for the prediction of traffic noise in India under its own limitations of accuracy. The assessment of observed noise levels with respect to standards is also presented and it is recommended that the regulation of traffic volume and speed can be implemented to control the noise within permissible limit. The outcome of the study may be of immense help in traffic planning and environmental assessment of the highway projects especially with respect to traffic noise. It is recommended that traffic noise assessment should be taken up on all the highway of the country on priority with a view to ascertain the status of noise pollution in the adjoining areas and the effect on human health.**

Keywords*— Federal Highway Administration (FHWA), Sound level, Equivalent continuous noise level (Leq), dB (decible).

INTRODUCTION

Noise is generally described as unwanted sound and completely subject to personal tastes and tolerance levels. In addition, the sensitivity of the human ear to noise depends on a number of contextual factors which typically include wind, humidity, traffic density, etc. Nevertheless, it is generally accepted that a 55 dB (A) sound will be disturbing whereas a 65 dB (A) noise level will be deemed intolerable, causing severe sleep disturbance (source-OECD). Much of this is caused by traffic-related sound originating from all modes of transport. Road traffic noise, in particular, is caused by the combination of rolling noise (arising from tyre road interaction) and propulsion noise (comprising engine noise, exhaust systems and transmission intake). It is usually estimated that tyre-road interaction is the main source of noise above 55 kmph for most cars and above 70 kmph for trucks, depending on the age, weight and driving conditions of the vehicles. Significant progress has been achieved in both sources of noise, through new tyre design (such as randomized run pattern, narrow lateral grooves, etc.) and quieter engines (through acoustic shielding of the engine and multiple muffler systems). However, there remains much scope for progress - particularly as quieter cars will never eliminate erratic driving behavior, technical defects or even traffic density which together can have a multiplying effect on noise emission. In addition, an overall increase in road traffic and the progressive introduction of heavier vehicles have tended to counter-balance the real progress achieved through better car and tyre technology. Traffic noise is a typical area of conflict between individual mobility needs and legitimate societal aspirations for quieter lifestyles. Public suffering from unacceptable levels of noise – much of it caused by the transport sector as a whole – there is a clear need for public to take a driving role in promoting targeted legislation, sharing solutions and achieving a common understanding of the potential for progress. Public concern over noise issues has never been so high, partly because the overall increase in road traffic has tended to counterbalance the real progress achieved by all segments of the road transport sector in the last decade. Highway noise is the sum of the total noise produced at the observer point by all the moving vehicles on the highway. Vehicle noise is created by engine and exhaust system of vehicles, aerodynamic friction, interaction between the vehicle and road system, and by the interaction among vehicles. While road traffic noise components are to be found essentially in propulsion noise and tier-road interaction, the vast array of preventive and remedial measures extends to quieter road technology, noise reducing devices, traffic management strategies and long-term mobility and land use planning solutions. The real challenge therefore lies in identifying a combination of pragmatic measures that will reduce overall sound emission without impeding mobility and its associated socio-economic benefits. This piece of work on Road Traffic Noise provides to understanding how the road sector can contribute to this goal.

The traffic noise of motor vehicles, in urban areas, may lead to the environmental problems which might affect adversely human health and might also lead to lower working efficiency and productivity. Therefore, the control of traffic noise has become a matter of major concern for communities trying to maintain a satisfactory environment in which they can live and work to ensure high qualities environmental. It is necessary to know functional relationship between noise emission and the related traffic parameter. In this work the result of traffic noise assessment based on the application of FHWA model on the experimental data collected by systematic noise measurement along a highway corridors near Gorakhpur city are presented.

The effects of noise on human health and comfort are divided into four categories depending on its duration and volume. They are (i) physical effects such as hearing defects, (ii) physiological effects such as increased blood pressure, irregularity of heart rhythms (iii) psychological effects such as sleeplessness, going to sleep late, irritability, annoyance and stress (iv) effects on work performance such as reduction of productivity and misunderstanding what is heard. Therefore, assessing the problem and programming actions for controlling noise and its adverse effects have become an issue of immediate concern for community. In India, through the comprehensive Environment (Protection) Act, 1986 air act noise pollution has become an offence. In the recent past, the Government of India has introduced The Noise Pollution (Regulation and Control) Rules, 2000 for the noise producing and generating sources which clearly classifies our environment into four categories and specifies the allowable limits of noise separately for day and night time for different urban environments. The ambient levels of noise for different areas/zones specified in the rules are indicated in table 1.

Table 1: Ambient noise standards

Area Code	Category of Area/Zone	Limits in dB*	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

**The limit in dB denotes the time-weighted average of the level of sound in decibels on scale A which is relatable to human hearing.*
Source: Environment (Protection) Act, 1986 as amended in 2002

Although significant numbers of research papers have been published on various cities of India, S.Sampath et al (2004), Vidyasagar and Rao (2006), Gangwar et al (2006), Chauhan and Pande (2010), Alam Wazir (2011), Gosmami et al(2011), Hunashal B. Rajiv et al (2012), Pandey and Dubey (2012), Mishra and Srivastava (2012) ,Pandey and Renesha(2013) carried out noise level assessment of Kerala, Vishakhapatnam, Bareilly, Guwahati, Dehradun, Bhadrak city, Kohlapur cities, Gorakhpur city(NH28), Navi Mumbai and Gorakhpur city respectively and all of them found that the noise level of their respective cities was higher than the prescribed limit by Noise Pollution (Control and Regulation) Rules, 2000. With the rapid increase in commercial activities in the Gorakhpur city during past several years, it is proposed to carry out the assessment of outdoor and indoor noise levels in the commercial areas of the Gorakhpur city. The present paper highlights the same.

NOISE LIMIT FOR VEHICLES

Every motor vehicle shall be constructed and maintained so as to conform to noise standards as indicated in the Table. 2. And these Standards shall be tested as per Indian Standards IS : 3028.(Source : Central Motor Vehicles Rules, 1989)

Table 2. Noise standards of Central Motor Vehicle Rules, CMVR, 1989

S No.	Category of Vehicles	Maximum Permissible Noise Level dB(A)
1	Two wheelers (Petrol driven)	80
2	All passengers cars, all Petrol driven three-wheelers and diesel driven two wheelers	82
3	Passenger or Light Commercial Vehicles including three wheelers vehicles fitted with diesel engine with gross vehicles weight up to 4000 kg.	85
4	Passenger or Commercial Vehicles with gross vehicles weight above 4000 kgs and up to 12000 kg	89
5	Passenger or Commercial Vehicles with gross vehicles weight above 12000 kg.	91

NOISE CONTROL MEASURES ON HIGHWAYS

The noise control measures on highway include the noise barrier and speed control.

Noise barrier

Noise barriers can be applicable for existing or planned surface transportation projects. They are probably the single most effective weapon in retrofitting an existing roadway, and commonly can reduce adjacent land use sound levels by ten decibels.

Speed Control
It is effective since the lowest sound emissions arise from vehicles moving smoothly at 30 at 60 kilometers per hour. Above that range sound emissions double with each five miles per hour of speed. At the lowest speeds, braking and (engine) acceleration noise dominates.

Traffic management strategies
It can play an important role in reducing noise at the source (e.g. nigh time speed limitation, "quiet areas". etc.), especially coupled with effective high technologies and enforcement policies which enable and active monitoring of the worst noise offenders

FHWA MODEL

Highway traffic noise has been a federal, state, and local problem, even before the first noise barrier was built in 1963 in USA. Over the years, community and motorist concerns have fueled the push to improve noise measurement and modeling tools that aid transportation agencies in addressing the highway traffic noise problem. One such tool is the Federal Highway Administration Traffic Noise Model (FHWA TNM). The FHWA TNM is a new state-of-the art computerized model used for predicting noise impacts in the vicinity of highways. It uses advance in acoustics and computer technology to improve the accuracy and ease of modeling highway traffic noise, including the design of efficient, cost-effective highway noise barriers.
The Federal Highway Administration's (FHWA) Environmental Policy Statement includes a commitment to ensure that all feasible mitigation measures are incorporated into projects to minimize noise impacts and enhance the surrounding noise environment to the extent practicable. This commitment to minimize noise impacts and enhance the noise environment is fulfilled through prudent application of FHWA. The algorithms are based on the concepts of a series of adjustments to reference sound level. This reference sound level should be at distance of 15.2 meters for a single vehicle travelling along an infinitely long straight level, road with no shield of source. Adjustment are then made for total traffic flow, the actual distance of receiver from the road, the extent of road segment being considered, the type of ground cover between the source, the receiver, shielding of the source and the gradient of the road. The vehicle population is divided into three groups

(i) Automobiles
(ii) Medium trucks
(iii) Heavy trucks

To use the FHWA model one needs

(i) The hourly flow rates for each vehicle type
(ii) The average operating speed of each vehicle type
(iii) Distance of the receiver from the road edge

The FHWA TNM contains the following modeling components

- Five standard vehicle types, as well as user defined vehicles.
- Constant-flow and interrupted-flow traffic.
- Effects of different pavement types and graded roadways.
- Sound-level computations based on a one-third octave-band database and one-third octave-band algorithms.
- Graphically interactive noise barrier design optimization.
- Attenuation over/through rows of buildings and dense vegetation.
- Multiple diffraction analyses.
- Parallel barrier analyses.
- Contour analyses.

Modification of FHWA model in Indian context
In a study carried out in India, (Jain and Parida, 2001) noise emission equation has been used for FHWA model. But in this model original adjustment factor have been retained as such. The vehicles are classifieds in seven categories and the detailed method has been described here. The hourly L_{eqi} value for each category of vehicle is calculated using the formula

$$L_{eqi} = L_O + A_{vs} + A_D + A_S$$

L_{eqi} = Hourly equivalent noise level for each vehicle type
L_O = The reference energy mean emission level
A_D = Distance correction
A_{vs} = Volume and speed correction for subscribe
A_S = Ground cover correction
The reference energy mean emission level (L_O)
Regression equation is obtained in logarithmic form for noise levels emission of each type of vehicle with its respective speed. The regression equation has been derived for the reference energy mean emission level and such equation is called individual vehicle noise emission equations.

Volume and speed correction
The hourly flow of each vehicle category (Veh/hr) and the average speed of each category (km/hr) are used for calculation of L_{eq} value. Therefore this model incorporated the volume speed correction that is applied for final L_{eq} value. The correction is given as:

$$A_{vs} = 10 \text{ Log } (D_O\ V/S) - 25$$

Where,
V = Volume for the category (Veh/hr)
S = Speed (km/hr)
D_O = Reference distance (m/s)

Distance correction
When calculating distance adjustment the type of intervening ground cover between the highway and reception point is also considered.

$$A_D = 10 \text{ Log } 10 \, (D_O / D) \, 1 + \alpha]$$

Where,
D_O = Reference distance given as 10 meters
D = Distance of measurement from center of each lane
α = Ground cover coefficient

The value of α is different for different location because the value is depending upon the amount of absorption at each location, which in turn depends upon the type of ground cover. Ground cover absorption coefficient is assigned a value ranging from 0 to 0.75 depending upon the type and extent of ground cover as presented in table 3.

Table 3. Land cover coefficient

Type of ground	Ground cover coefficient
Hard stations	$a = 0$
Moderately reflective	$a = 0.25$
Absorptive ground	$a = 0.5$
Very absorptive	$a = 0.75$

Calculation of equivalent noise level

Noise level for each vehicle type (L_{eqi}) is calculated and then calculates logarithmically to get the total hourly L_{eq} value and the combined hourly L_{eq} value is calculated by logarithmic summation of hourly L_{eq} value of each category.

$$L_{eq} = 10log \sum_{i=1}^{i=n} 10^{L_i/10} \times t_i$$

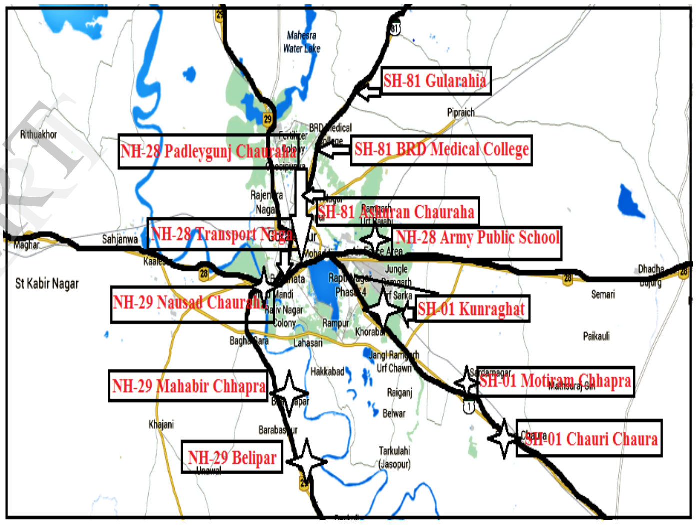
Where n = total number of sound samples
L_i = noise level of any i^{th} sample
t_i = time duration of i^{th} sample expressed as fraction of total sample time

Methodology

The FHWA Model predicts hourly Leq values for free-flowing traffic conditions, and is generally considered to be accurate to accurate within +1.5 dB (A). To predict Ldn values, it is necessary to determine the hourly distribution of traffic for a typical 24 hours day and to adjust the traffic volume input data to yield an equivalent hourly traffic volume. Using these data and the FHWA methodology, traffic noise levels have been calculated for existing and future conditions. Distances from the centerlines of the major roadways are taken as 10 meters. These calculations do not include consideration of shielding caused by local buildings or topographical features, so the distance reported (10 metre) are the worst case estimates of noise exposure along highways in the city. The quality and quantity of traffic affect the highway noise level. According to the standards of FHWA model, the observations are taken. Bidirectional measurement of traffic volume along with speed with fixed observation distance from the centerline of the road has been considered for all the sampling stations. The noise level observations also have been taken from selected locations and a comparison has been presented between the observed values and predicted noise levels using FHWA model. In the present study, data were collected from 12 stations in Gorakhpur city .The basic noise data were obtained using sound level meter (Bruel and Kajer 2232) placed 1.2 meter above the ground. Vehicles have been divided into seven categories like motorcycle scooter, autorickshaw, car/jeep/van, low commercial vehicle/minibus, bus, truck and tractor/trailer. A field data collection program was chalked out to collect data regarding the following parameters: classified traffic volume, classified traffic speed and ambient noise level.

Selection of Sampling Locations

On National Highway (NH28, and NH29) and State Highway (SH01, and SH81), total number of 12 sampling stations have been selected for the observation of traffic volume, speed and noise level. A map showing highways selected for the study in the vicinity of Gorakhpur is given in Fig. below.



National and State Highways in the Vicinity of Gorakhpur city

Methodology of Noise and Traffic Data Collection

Measurement of ambient noise level

Sampling has been done at mid hour from 25 minute to 35 minute for 10 minutes duration. The noises are recorded at 15 second interval and hence for 10 minute duration, 40 data are recorded. The recording is done with the help of precision sound level meter of make ‘Bruel and kjaer’ Denmark (2232) and in dB (A) weighting network. During the sampling process the distance from the centerline of the road was 10 meters and the height of sound level meter was 1.2 meter from the ground level.

Traffic volume

Traffic volume is calculated manually at selected observation stations. Total number of vehicles passes in each

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 12, December-2014

type passing in one hour in a single direction is recorded in terms of vehicles/hour.

Spot speed measurement

Generally the traffic spot speed is measured with the help of Doppler Radar Speedometer. But owing to the non-availability of Doppler Radar Speedometer, manual method of spot speed measurement was resorted to the present study. For this purpose, two points are marked with a known distance (75 metre) on the road at the sampling station.

With the help of stop watch, the time taken by the vehicle to cross that distance is recorded. Dividing the distance with the time taken in crossing the distance, the speed in kmph for each type of vehicle is calculated and recorded for each hour of study.

The emission equations developed by Pandey and Pattnaik (2011), are given in Table 4 and are used in the calculation of predicated noise levels.

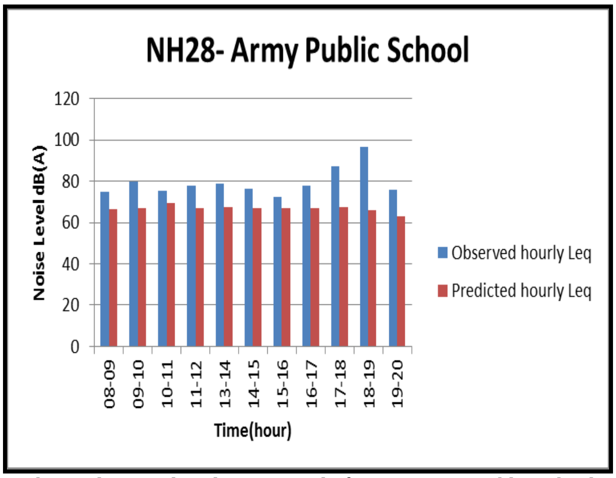
Table 4. Individual Vehicle Noise Emission Equations (Pandey and Pattnaik, 2011)

S. No.	Category of vehicle	Individual vehicle noise emission equation
1	Scooter/Motorcycle	Y=59.364+0.9317Ln(S)
2	Auto-Rickshaw	Y=88.527-4.8433Ln(S)
3	Car/Jeep/Van	Y=68.992-0.0796Ln(S)
4	Truck	Y=39.012+10.074Ln(S)
5	LCV/Minibus	Y=54.908+4.9153Ln(S)
6	Bus	Y=10.253Ln(S)+37.867
7	Tractor/Trailer	Y=5.3257Ln(S)+60.83

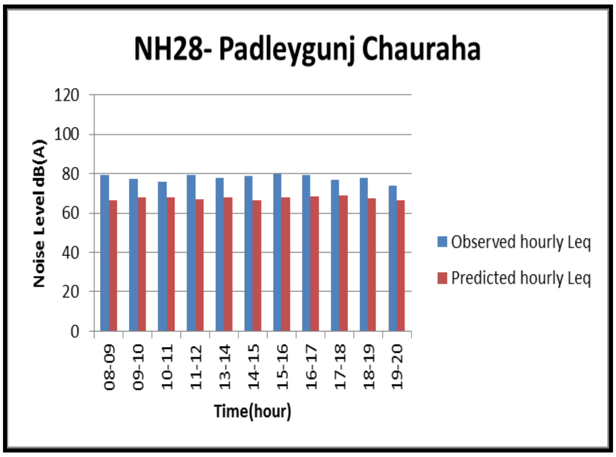
Y= Reference energy mean emission level

S= Speed (Km/h)

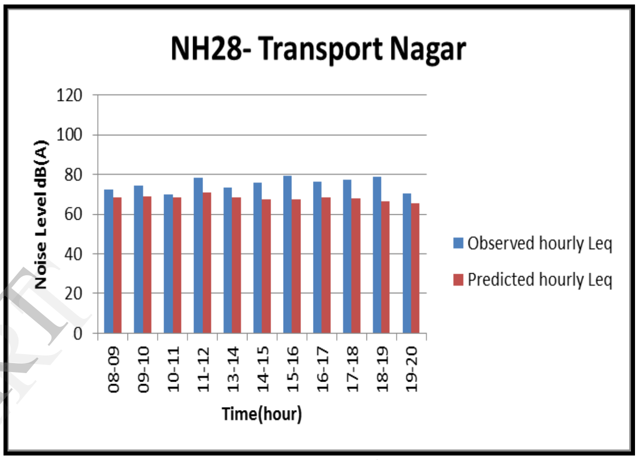
A relative standing of observed and predicted noise levels at various sampling station has been shown in Fig.



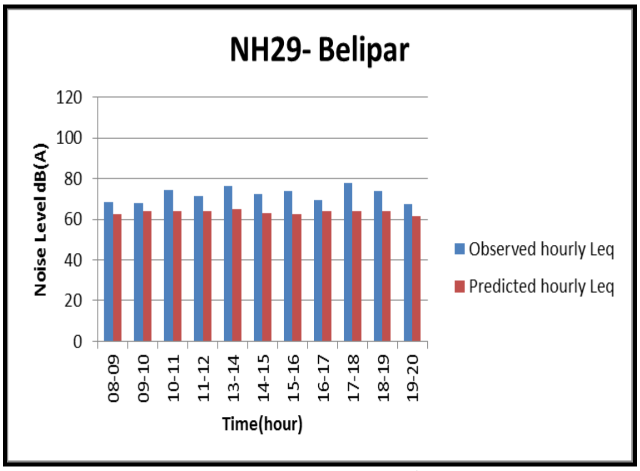
Observed vs. Predicted Noise Level of NH28- Army Public School
Date: 02/08/2014



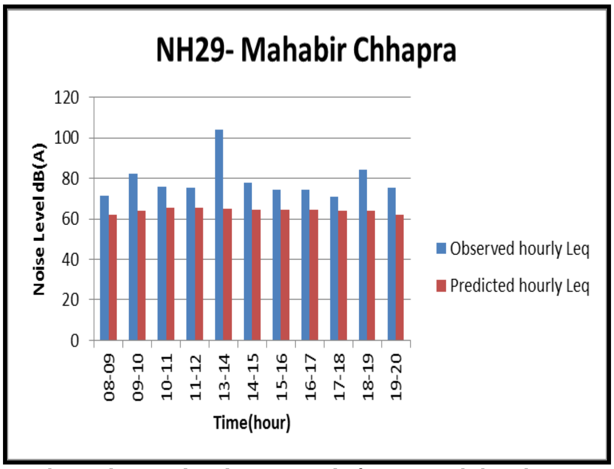
Observed vs. Predicted Noise Level of NH28- Padleygunj Chauraha
Date: 02/09/2014



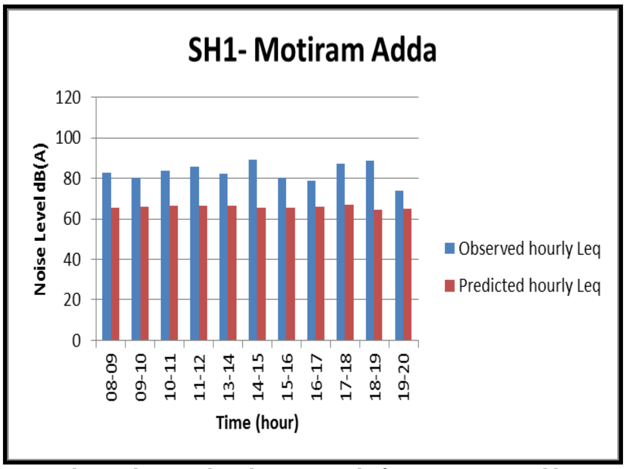
Observed vs. Predicted Noise Level of NH28- Transport Nagar
Date: 10/08/2014



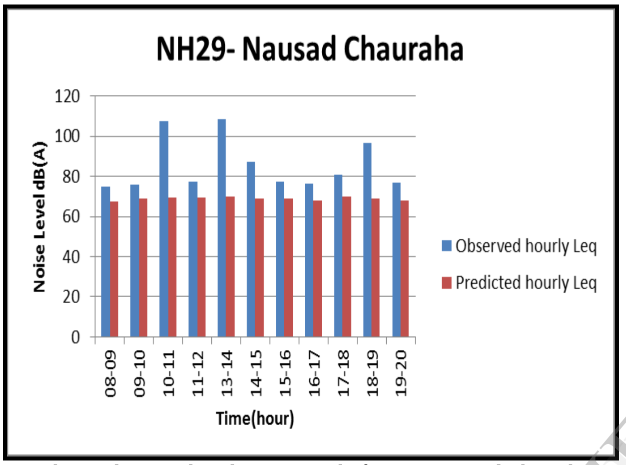
Observed vs. Predicted Noise Level of NH29- Belipar
Date: 15/08/2014



Observed vs. Predicted Noise Level of NH29- Mahabir Chaapra
Date: 17/08/2014



Observed vs. Predicted Noise Level of SH1- Motiram Adda
Date: 31/08/2014



Observed vs. Predicted Noise Level of NH29- Nausad Chauraha
Date: 20/08/2014

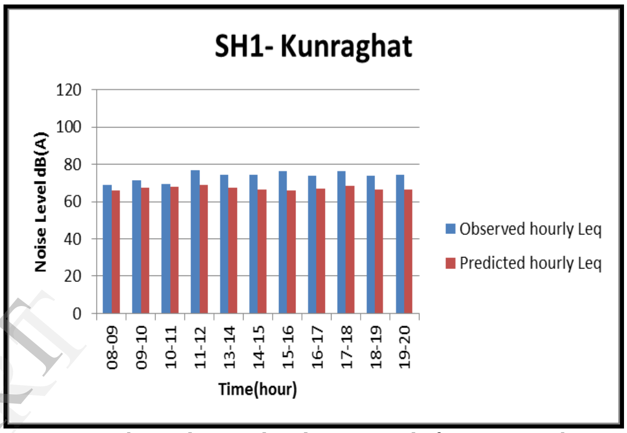
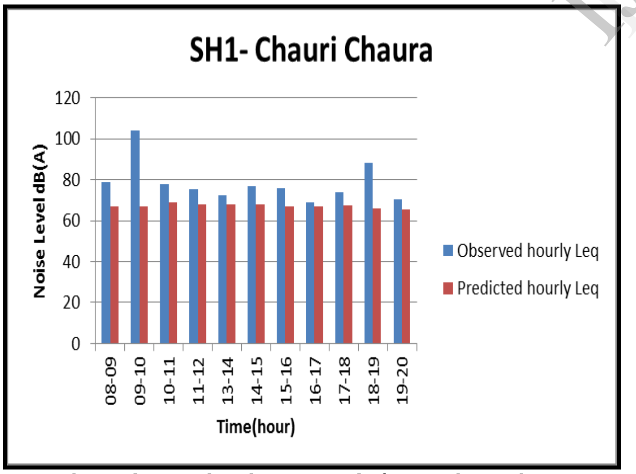


Fig. 4.9 Observed vs. Predicted Noise Level of SH1- Kunraghat
Date: 06/08/2014



Observed vs. Predicted Noise Level of SH1- Chauri Chaura
Date: 09/08/2014

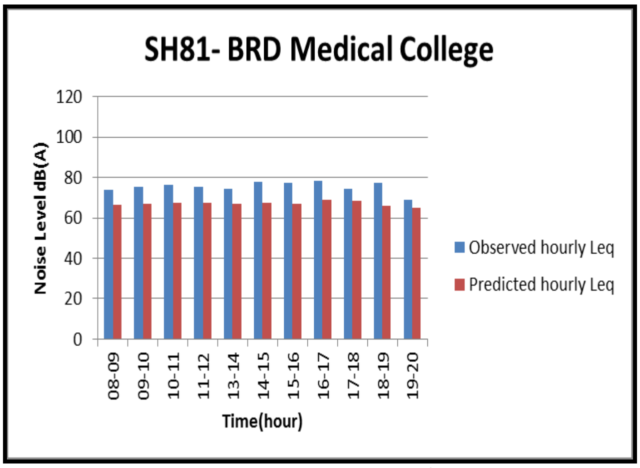


Fig. 4.10 Observed vs. Predicted Noise Level of SH81- BRD Medical College
Date: 03/08/2014

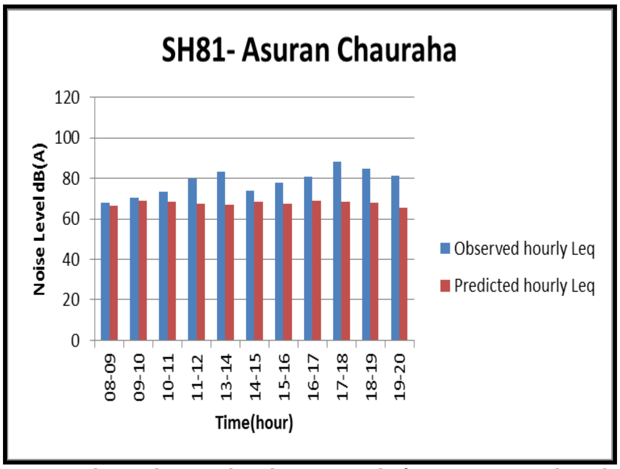


Fig. 4.11 Observed vs. Predicted Noise Level of SH81- Asuran Chauraha
Date: 01/08/2014

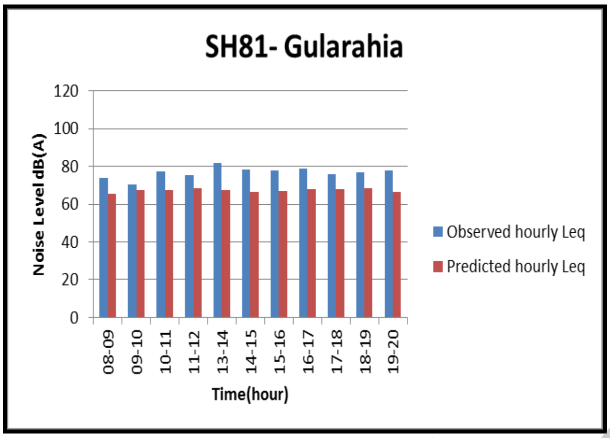
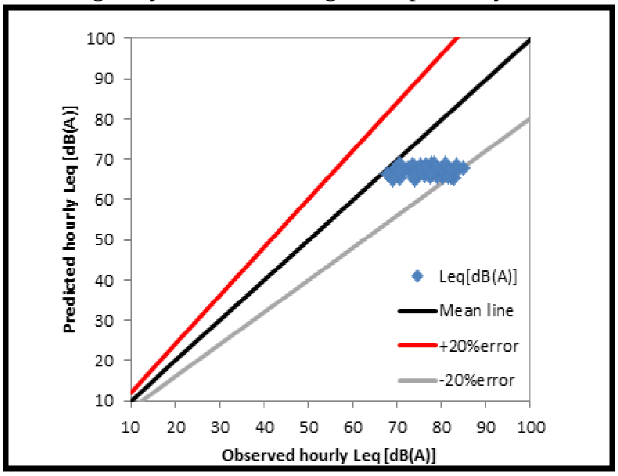
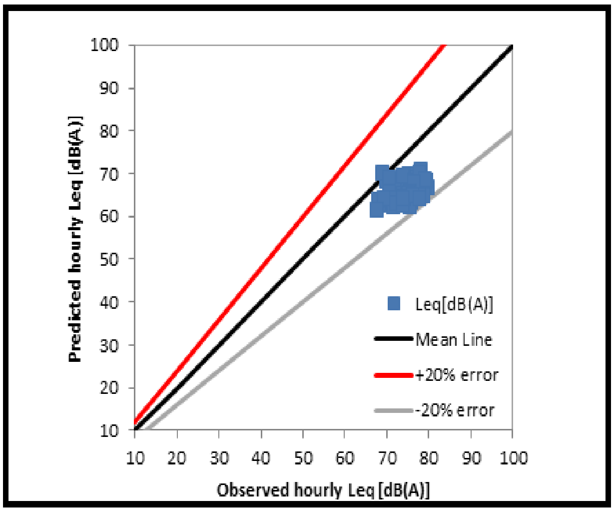


Fig. 4.12 Observed vs. Predicted Noise Level of SH81- Gularahia
Date: 25/08/2014

The agreement diagrams for National Highways and State Highways is shown in figure respectively.



Agreement diagram between observed and predicted noise levels dB (A) along NH-28, NH-29



Agreement diagram between observed and predicted noise levels dB (A) along SH-1, SH-81

RESULTS AND DISCUSSIONS

Ranking of sampling stations in terms of the maximum observed noise levels, minimum observed noise levels, acceptable noise levels and difference between maximum and acceptable noise levels are as follow.

NH28- Army Public School: - The maximum observed noise levels is 96.74dB (A) between 18- 19 hour and minimum observed noise levels is 72.61 between 15-16 hour.

NH28- Padleygunj Chauraha: - The maximum observed noise levels is 79.44dB (A) between 16-17 hour and minimum observed noise levels is 73.94dB (A) between 19-20 hour.

NH28- Transport Nagar: - The maximum observed noise levels is 79.1dB (A) between 15-16 hour and minimum observed noise levels is 70.07 dB (A) between 10-11 hour.

NH29- Nausad Chauraha: - The maximum observed noise levels is 108.54 dB (A) between 13- 14 hour and minimum observed noise levels is 74.9 dB (A) between 08-09 hour.

NH29- Mahabir Chhapra: - The maximum observed noise levels is 103.79 dB (A) between 13- 14 hour and minimum observed noise levels is 71.14 dB (A) between 17-18 hour.

NH29- Belipar: - The maximum observed noise levels is 77.78 dB (A) between 17-18 hour and minimum observed noise levels is 67.62 dB (A) between 19-20 hour.

SH1- Chauri Chaura: - The maximum observed noise levels is 103.81 dB (A) between 09-10 hour and minimum observed noise levels is 68.95dB (A) between 16-17 hour.

SH1- Motiram Adda: - The maximum observed noise levels is 89.24 dB (A) between 14-15 hour and minimum observed noise levels is 73.94dB (A) between 19-20 hour.

SH1- Kunraghat: - The maximum observed noise levels is 76.22 dB (A) between 15-16 hour and minimum observed noise levels is 68.83 dB (A) between 08-09 hour.

SH81- Ashuran Chauraha: - The maximum observed noise levels is 83.27 dB (A) between 13- 14 hour and minimum observed noise levels is 67.84 dB (A) between 08-09 hour.

SH81- BRD Medical College: - The maximum observed noise levels are 78.38 dB (A) between 16-17 hour and minimum observed noise levels is 69.07 between 19-20 hour.

SH81- Gularahia: - The maximum observed noise levels is 81.79 dB (A) between 13-14 hour and minimum observed noise levels is 70.21dB (A) between 08-09 hour.

A graphical presentation in the form of bar charts indicating observed and predicted values of noise levels at various sampling stations is shown in Fig. which show that the predicted values are mostly in close proximity with the observed values. However the range of predicted values lies up to -20% and thus it can be inferred that most of the predicted values are lower than the observed values.

CONCLUSION AND RECOMMENDATIONS

The analysis of data has revealed that the observed noise levels along all the highway corridors of namely NH-28, NH-29, SH-01, and SH-81 Gorakhpur city are alarmingly high. Hence the steps need to be taken for the control of noise by the prescribed authority.

For traffic regulation purposes directed towards noise control, the restrictions on traffic flow and speed can be planned especially along the noisy highway corridors that are located in the vicinity of cities and urban areas, using the outcome of this study. It is also felt that the regulation of traffic volume and speed at sensitive points like Nausad Chauraha, Mahabir Chhapra, Chauri Chaura, and Army Public Schoolmay prove to be quite helpful in reducing the noise levels along the highway corridors. Improvement if pavement surface may also be helpful in reducing the noise.

Noise barriers like vegetation along the roads can be quit useful for the areas located in the neighborhood on the two sides. They are probable the single most effective weapon in retrofitting an existing roadway, and commonly, can reduce adjacent land use sound levels by up to ten decibel or so.

It is expected that the noise control along the highways by the regulation of traffic volume and speed can be successfully implemented in India and elsewhere and FHWA model may prove to be quite useful in traffic planning in this perspective under its own limitation of accuracy.

In view of the same, the outcome of the study may be of immense help in traffic planning and environmental assessment of the highway projects especially with respect to traffic noise. It is recommended that traffic noise assessment should be taken up along all the highway of the country on priority with a view to ascertain the status of noise pollution in the adjoining areas and the effect on human health.

REFERENCES AND BIBLIOGRAPHY

1. S. Sampath, Das Murali S., Kumar Sasi V. (2004): Ambient noise levels in major cities in Kerala, J. Ind. Geophys. Union, Vol.8.No.4,pp 293-298.
2. T. Vidya Sagar And G. Nageshwar Rao (2006), 'Noise Pollution Levels in Visakhapatnam City (India)', Journal of Enviornmental Science and Engineering, 48(2), pp 139-142.
3. Gangwar, KK., Joshi, BD and Swami, A. (2006) : Noise pollution status at four selected intersections in commercial areas of Bareilly, Metropolitan City. Him.J.Env.and Zoo.,20(1)75-77.
4. Chauhan and Pande (2012), Study of noise level in different zones of Dehradun city,Uttarakhand, Report and opinion 2010, 2(7).
5. Alam, Wazir (2011), 'GIS based Assessment of Noise Pollution in Guwahati City of Assam, India', International Journal of Environmental Sciences, 2(2), pp 731-740.
6. Hunashal B. Rajiv, Patil B. Yogesh (2012) Assessment of noise pollution indices in the city of Kohlapur, India, International Conference on Emerging Economics- Prospects and Challenges(ICEE-2012), Procedia – Social and Behavioral
7. Arun kumar Mishra, Prabhat Srivastava "Assessment and Prediction of Noise Level on Various Links in the Surrounding Areas of an Upcoming Airport" IJRET, ISSN: 2319-1163.
8. Cunnif F. Patrick "ENVIRONMENTAL NOISE POLLUTION" ISBN 0-471-18943-X, Library of Congress Cataloging in Publication Data.
9. CPCB website: http://cpcb.delhi.nic.in., (2010).
10. Gorakhpur City Guide (2005), A times of India Publication, Bennett, Coleman & Co. Ltd., New Delhi, pp 8-10.
11. Goswami Shreerup, Panda k Santosh, Swain k Bijay "Dynamics of road traffic noise in Bhadrak city, India, 2011, J. Environ. Biol, ISSN: 0254-8704.
12. http://www.fhwa.dot.gov, (2010).
13. http:/ / enwikipedia.org/wiki / indian road_network, (2010).
14. http://www.mapsofindia.com/drivingdirections-maps/nh28-driving-directions, (2010).
15. Pandey Govind and Renesha Singh,2013 A Study of Noise in Gorakhpur City, Uttar Pradesh (India). Int. journal Of structural and Civil engg. Research. 02, pp. 241-249.
16. Pandey Govind and Dubey Soni "Traffic Noise Prediction using FHWA Model on National Highway - 28 in India" J. Environ. Res. Develop. Vol. 7 No. 1, July-September 2012
17. The Noise Pollution (Regulation and Control) Rules, 2000, CPCB Delhi from http://cpcb.delhi.nic.