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Development of Noise Model for Traffic Associated Parameters for NH-44 (Yelahanka to Chikkajala Fort Stretch)

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Abstract*— Traffic connected noise pollution accounts for almost two-third of the total noise pollution in an urban part. Noise, a result of urbanization, industrialization and motorization, is gradually accepted as an environmental irritation that results the human health and comfort. Traffic noise on present urban roadways reduces the value of life and the property values for persons living near these urban passages. With the increase in population, Bangalore is now the home to the second highest number of vehicles of climbing to 70.28 lakh at the end of 2017. Thus, leading to increase in traffic related noise pollution. This paper highlights the noise pollution study carried out on NH-44 for a stretch of 10.2kms from Yelahanka to chikkajala fort.

Keywords: Noise pollution, burgess model

INTRODUCTION

Road-noise is identified as-the most wide spread & annoying source of noise. Because of the increasing number & usage of road vehicles, the results are that stringent measures are taken to control it. Its intensity will continue to increase steadily we in to the foreseeable future. It is one of the important alarm systems in physical environment of human beings & other living beings. Noise disturbance due to traffic has a detrimental effect on the tranquility of the area and is particularly annoying in the vicinity of the noise sensitive areas. Poor riding surface, poor vehicle maintenance, high speed and bad driving also add to noise levels. It is one of the major environmental pollutants that are encountered in daily life. Traffic noise will continue to increase in magnitude and severity because of population growth urbanization and the associated growth in the use of automobiles. Therefore, future prediction of the noise level for any new transportation projects becomes essential so that noise control measures could also be planned. Bangalore, -also known as Bengaluru is the capital of the Indian state of Karnataka. A demographically diverse city, Bangalore is the second fastest-growing major metropolis after New Delhi in India. , with a growth rate of 38% between 1991 and 2001. Increasing number of road vehicles has created serious threat of noise pollution. The expansion of Bangalore city in all the directions to accommodate a large influx of increasing population from the neighboring villages, - cities and states of the country, - attracted by large public and private sectors have exercised a tremendous pressure on the cities overall environment. Over the past two decades, Bangalore is experiencing a tremendous increase in growth of increasing vehicular traffic
The main objective of this study is to bring the eco-friendly environment to the society for this many aspect are needed to be performed. One of which is to monitor and assess ambient noise levels on major corridors of NH-44 and to measure the noise levels at various junctions and mid-blocks and compare them with standards as per CPCB/WHO and also other organizations. The study also is to suggest and recommend a noise level in building by-laws to ensure eco-friendly environment during the planning stage. A mathematical model relating traffic parameters is developed to study the variation of noise levels from road side kerb. Concluding the study by identifying the various significant sources of noise and to implement various suggestive remedies to reduce the noise levels.

II. METHODOLOGY AND ANALYSIS

Selection of Site

To develop arithmetical model for forecasting the traffic noise, the first job was site choice. A partly six lane and partly four lane straight stretch where continuous endless flow of vehicles occurs, without any obstructions like speed breaker, junctions, traffic signals etc. was selected on Bangalore - Hyderabad road (NH-44) via Anantapur.

Selection of Junctions and Midblock

The national highway – 44, connecting Bangalore to Hyderabad via Anantapur which is partly a six lane and a partly four lane highway was selected for the purpose of study. A total stretch of about 10.2 kms was selected along the national highway – 44 from Yelahanka to Chikkajala fort. The street of 10.2 kms mainly consists of 3 major junctions namely;

1. Yelahanka
2. Air Force Station (AFS), Yelahanka
3. Chikkajala Fort

The overall distance of the stretch and the distance between each junction were measured from Bangalore side approaching Hyderabad. The first junction is Yelahanka which is the beginning point of the study. The second junction is Air Force Station (AFS), Yelahanka which is located at a distance of about 3.9 kms from the first junction. The third junction is chikkajala fort which is located at a distance of about 6.3 kms from the second junction and of about 10.2 kms from the first junction. The total length of the selected stretch for the measurement of noise and other measurements is 10.2 kms. Since the traffic volume and its composition is considerably more at the junctions due to the presence of various other roads forming it a junction. The midblocks selected were in a way that they are straight in alignment and free from obstacles having a good visibility, free from parking, no pedestrians, zebra crossing and mainly no intersections etc., Reconnaissance survey was carryout out at three junctions and four midblock so as to understand the traffic issues and finally zeroing the exact location and also the time of the day where the peak traffic is observed, so that the final data collection is carried out these locations. The studies were carried out both on the weekdays and weekends along the Bangalore-Hyderabad highway. This is due to the fact that the noise is directly proportional to the traffic volume intensity.

Road Geometric Studies

The overall length of the 10.2 kms of NH-44 from Yelahanka to Chikkajala fort is completely a six-lane highway with three lanes on each side. The highway consists of partially shoulder and partially footpath on either direction of the road. NH-44 along this stretch is a six lane with a divided raised kerb median of about 20-25cm and also has a housing electric poles for the road side illumination. The distance of the carriageway i.e., pavement width and shoulder distance, distance of property line from carriageway with respect to kerb were measured and was noted down to 10.5 meters for 3 lanes on each side. The distance was measured in possible available places along the stretch of the road, coz along Bangalore to Hyderabad.

Traffic Volume Studies

Soon after the selection of junctions and midblock, and measuring the geometrics of the road, the traffic volume is counted for junctions both on weekdays and on weekends. The traffic volume count was done three days a week for every junction with two days on a weekday and one day on weekends.

Table 1: Volume at junction in PCU's/hr along with V/C and the corresponding LOS

Sl.No	Junction	Road Name	V (PCU/hr)	V/C	LOS
1	YELAHANKA	NH-44 (Bangalore towards Hyderabad)	1769	0.147	A
		NH-44 (Hyderabad towards Bangalore)	1521	0.126	A
2	AFS, YELAHANKA	NH-44 (Bangalore towards Hyderabad)	1628	0.135	A
		NH-44 (Hyderabad towards Bangalore)	1355	0.112	A
3	CHIKKAJALA FORT	NH-44 (Bangalore towards Hyderabad)	1683	0.140	A
		NH-44 (Hyderabad towards Bangalore)	1297	0.108	A

A:<0.2; B:0.21-0.4; C:0.41-0.6; D:0.61-0.8; E:0.81-1.0; F:1.0>

From the table 1, it is clear that the roads at the junctions are really good where the LOS measured varies between 0.108 (Junction-3, Hyderabad towards Bangalore) to 0.147 (Junction-1, Bangalore towards Hyderabad). Traffic volumes observed at the midblocks are given in table 2. From the table it is clear that the lowest V/C obtained is 0.099 for the stretch between Hyderabad towards Bangalore in the midblock-4 and maximum of 0.124 for the stretch between Bangalore to Hyderabad in the midblock-1.

Table 2 : Volume at midblocks in PCU/hr along with V/C

Midblock	Road Name	V (PCU/hr)	V/C
M-1	NH-44 (Bangalore towards Hyderabad)	1489	0.124
	NH-44 (Hyderabad towards Bangalore)	1129	0.094
M-2	NH-44 (Bangalore towards Hyderabad)	1411	0.117
	NH-44 (Hyderabad towards Bangalore)	1210	0.100
M-3	NH-44 (Bangalore towards Hyderabad)	1389	0.115
	NH-44 (Hyderabad towards Bangalore)	1235	0.102
M-4	NH-44 (Bangalore towards Hyderabad)	1419	0.118
	NH-44 (Hyderabad towards Bangalore)	1198	0.099

Vehicular Speed Study

As the speed increases, the noise levels tend to increase simultaneously. The three junctions were used for speed study as the speed at the junctions is almost equal to that of midblocks due to absence of obstacles or interruptions such as stoppages, halts, speed breakers etc. Hence for the speed studies analysis junctions were considered which could give maximum speed. From the cumulative percentage distribution diagram, the speed corresponding to 98^{th} percentile (design speed), 85^{th} percentile (upper speed limit), 15^{th} percentile (lower speed limit) and 50^{th} percentile (median speed) are obtained and presented in the table 3.

Table 3: various speed limits obtained from 'S' curve

JUNCTION	LOCATION (TWO ENDS)	98% (DESIGN SPEED)	50% (MEDIAN SPEED)	85% (USL)	15% (LSL)
J-1 (YELAHANKA)	BANGALORE TOWARDS HYDERBAD	112	73	85	50
	HYDERBAD TOWARDS BANGALORE	105	71	82	52
J-2 (AFS, YELAHANKA)	BANGALORE TOWARDS HYDERBAD	102	65	82	52
	HYDERBAD TOWARDS BANGALORE	102	65	85	56
J-3 (CHIKKAJALA FORT)	BANGALORE TOWARDS HYDERBAD	98	68	81	50
	HYDERBAD TOWARDS BANGALORE	101	70	82	51

Noise Measurement

For the measurement of noise, 'Noise meter' 'type 2' is used which gives the direct reading of the noise in terms of $L_{eq.}$ The noise measurement was taken at the following locations at each midblock and at junctions on the same day and time of the traffic volume count and vehicular speed measurement. The noise values obtained in the field is at kerb, shoulder and at property line which are as shown in the tables 4 and 5 respectively.

Table 4 : Noise at various junctions in dB (A)

	BANGALORE towards HYDERBAD			HYDERBAD towards BANGALORE		
	At property line	At shoulder	At kerb	At kerb	At shoulder	At property line
J-1	75.7	81.1	89.5	88.8	88.5	83.4
J-2	73.6	85.2	101.2	92.6	90.6	86.4
J-3	82.8	81.2	100.6	99.4	89.4	77.7

Table 5 : Noise at midblocks in dB (A)

	BANGALORE towards HYDERBAD			HYDERBAD towards BANGALORE		
	At property line	At shoulder	At kerb	At kerb	At shoulder	At property line
M-1	78.0	76.5	81.2	89.7	82.4	80.8
M-2	81.6	76.4	86.2	95.1	-	76.2
M-3	81.4	78.1	84.3	94.8	-	78.4
M-4	86.5	-	85.1	93.5	78.2	82.

INTERPRETATION

Relationship of Noise with Volume

To establish the possible relationship of noise with the volume, various statistical parameters are used such as correlation and regression analysis. For a given traffic volume flowing along the study stretch, three noise meters were used simultaneously to measure the noise level, one at the kerb, one at the property line and one at the shoulders. The measured data of the noise are presented in the table 6 along the V/C of the particular stretch. As per the studies conducted by sreehari et al., that is appropriate so as to obtain the relationship of the noise with respect to V/C rather than traffic volume alone. This will help to obtain the relationship of the noise with respect to the road congestion instead of road traffic alone.

Table 6 : Variation of noise with Volume

Midblock	Location	Total V PCU/hr	V/C	Noise at Kerb in dB(A)	Noise at Shoulder in dB(A)	Noise at Property Line in dB(A)
M1	BANG towards HYD	1489	0.124	81.2	76.5	78.0
	HYD towards BANG	1129	0.094	89.7	82.4	80.8
M2	BANG towards HYD	1411	0.177	86.2	76.4	81.6
	HYD towards BANG	1210	0.100	95.1	-	76.2
M3	BANG towards HYD	1389	0.115	84.3	78.1	81.4
	HYD towards BANG	1235	0.102	94.8	-	78.4
M4	BANG towards HYD	1419	0.118	85.1	-	86.5
	HYD towards BANG	1198	0.099	93.5	78.2	82

These charts are termed as variations of congestion with respect to the noise level. And, for all the study roads, the regression lines were developed along with r^2 value which was found quite encouraging. To donate explicitly, since at all places shoulder was not available, the relationship were obtained for the noise level at the kerb and at the property line. Two representing for each direction. The obtained relationships in terms of a mathematical equations along with r^2 values are presented in the table 7, indicating that there will be strong relationship that exists between the congestion level of the road with the noise.

Table 7 : Variation of noise with the volume in the selected study area

BANGALORE TOWARDS HYDERABAD		
V/C v/s noise at kerb	$y = -0.6x^3 + 3.75x^2 - 8.15x + 91.2$	$R^2 = 1$
V/C v/s noise at property line	$y = -1.3167x^3 + 10.25x^2 - 26.433x + 104$	$R^2 = 1$
HYDERABAD TOWARDS BANGALORE		
V/C v/s noise at kerb	$y = -0.25x^3 + 1x^2 - 1.55x + 95.9$	$R^2 = 1$
V/C v/s noise at property line	$y = 0.9833x^3 - 7.25x^2 + 13.667x + 74.6$	$R^2 = 1$

Relationship of Noise with Speed

Since the vehicular speed has a wide range of variations due to mixed traffic flow condition, the combined speed of all the vehicles as per IRC recommendations are considered for the present investigation. The values obtained are plotted on graph and analysed as below for 98th percentile speed (design speed to understand any deficiencies) 85th percentile value (upper speed limit which helps to install sign boards along the highway at the study locations which is considerably filled with pedestrian and vehicular activities together with road safety), 50th percentile (median speed at which most of the vehicle will have to move for safety condition) and 15th percentile speed (lower speed limit at which the vehicles moving will involve threat to the safety like bullock carts, cycles, autos).

The corresponding variation of noise with respect to the above speeds is formulated along with their mathematical equation and R^2 value. Of all the various curves generated, the more appropriate and the one which has to be used for highways is Upper Speed Limit as any vehicle moves beyond this speed will be booked for traffic violation.

Table 8 : variation of noise with speed at the study location

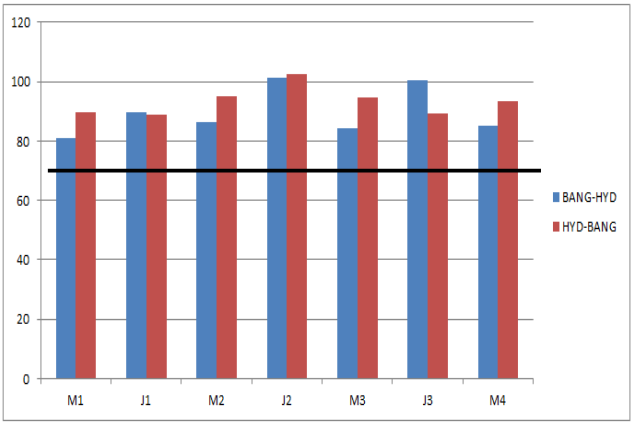
Bangalore towards Hyderabad	**Design speed**	$y = 0.8333x^3 - 2x^2 - 9.8333x + 123$	$R^2 = 1$
	Median speed	$y = -3.5x^3 + 26.5x^2 - 63x + 113$	$R^2 = 1$
	USL	$y = -1x^3 + 7x^2 - 17x + 96$	$R^2 = 1$
	LSL	$y = 1x^3 - 8x^2 + 19x + 38$	$R^2 = 1$
Hyderabad towards Bangalore	**Design speed**	$y = -0.8333x^3 + 6x^2 - 15.167x + 115$	$R^2 = 1$
	Median speed	$y = -1.3333x^3 + 11x^2 - 26.667x + 102$	$R^2 = 1$
	USL	$y = -2x^3 + 17.5x^2 - 44.5x + 100$	$R^2 = 1$
	LSL	$y = 1.8333x^3 - 15.5x^2 + 37.667x + 28$	$R^2 = 1$

The variation of noise with respect to the speed, when the noise meter was held at three different locations at row namely at the kerb (starting of the kerb footpath), at the end of the kerb/footpath and another one positioned at the place where the property line starts. This exercise was carried out to understand the variation of the traffic noise with the horizontal distances. In most of the locations, the noise level at the property line is beyond the permissible limits specified by the authorities. This causes health hazards and also demands the reduction in noise levels by various means and measures.

The variation of the traffic noise with respect to the varying horizontal distances from the noise source indicate clearly the reduction in the noise level. The chart are generated for both the directions where noise observation were made at the kerb level, shoulder/footpath edge and the property line.

The observed noise levels exceeding 65 dB(A) at kerb level for all the locations M1-M4 and junctions J1-J3. From the observations it is clear that the measured noise levels are exceeding the prescribed limit of 65 dB(A) at all the locations which is alarming and required immediate attention of the authorities to reduce the noise levels which is indicated in the figure 1

Figure 1 : variation of noise levels exceeding 65 dB(A) at kerb for the study location



Comparison with Burgess model

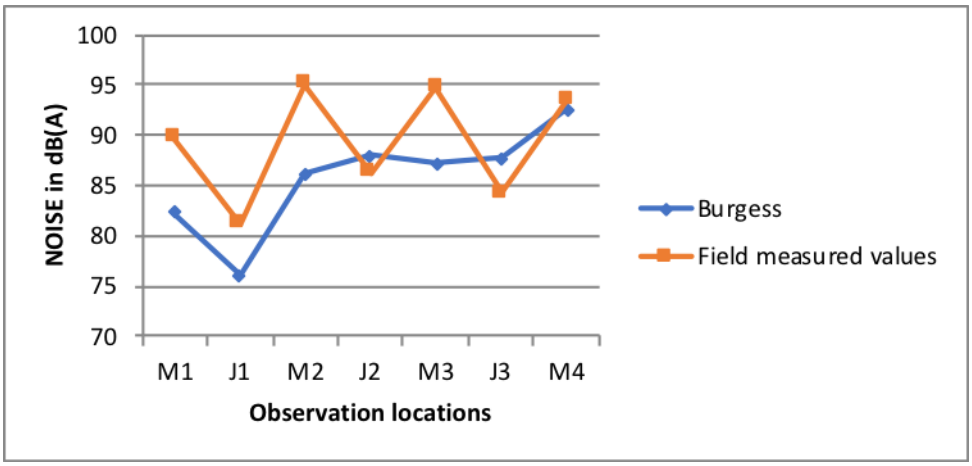
In order to validate the field values measured for the noise and the standard model developed by Burgess, considering pavement width, vehicular volume in PCU's/hr and % composition HTV's are compared for the validation. From the table 9, it is clear that there is a lot of variation and also not significant as per obtained square of the error and least square of the error. Hence the measured values are not in the line with the burgess model which is developed for the purpose.

Table 9 : Comparison of measured values of noise with burgess model

Burgess	Field measured values	Variation (e)	e^2	Least square error`
82.3	89.7	7.4	54.76	1.95
76.01	81.2	5.19	26.94	
86.09	95.1	9.01	81.20	
87.97	86.2	-1.77	3.13	
87.17	94.8	7.63	58.21	
87.75	84.3	-3.45	11.90	
92.54	93.5	0.96	0.92	
85.80	85.1	-0.7	0.49	
			237.55	

The comparison between the burgess model and the field measured values at the selected junctions and midblocks is as shown in the figure 2.

Figure 2 : Comparison between the burgess and field measured values



III.RESULTS AND DISCUSSION

The variation of noise with respect to the traffic volume, vehicular speed (design speed, lower & upper speed limits and median speed) at kerb, shoulder and property line is compared to the Burgess model developed with special reference to the traffic volume, HTV's and road geometrics as specified for the highway. The percentage of least square obtained as 1.95, this indicates that the values measured are in close proximity to Burgess model particularly in case of highways.

There is a strong need for the people and for the authorities in Bangalore to ensure clean environment for the people and society at large. The measured noise levels at all the study stretch rewards the highest value of and at one or two locations almost nearing 100dB (A). It is alarming and hence immediate steps should be taken towards abating the noise levels and bringing back within the stipulated limits. The road side buildings having direct impact of the noise, must use double glazes windows, also doors and windows should be installed with rubber beadings to arrest the unwanted noise. Shrill horns must be prohibited as far as possible along with asking all the vehicle drivers to switch off their vehicle engines at signals as it has several advantages.

It is strongly recommended that, where ever possible (Bangalore-Hyderabad and Hyderabad-Bangalore) to grow rows of trees as a buffer blanket which absorbs the noise by more than 15dB (A) as specified in other countries. Some strict by laws for building offsets do also help based on the present studies as noise would decrease by 6dB (A) as horizontal distances is increased by from the noise pollution. Maintenance of vehicles in good condition is necessary, as it does help in the reduction of noise levels and this measure must be taken to all the road users possible by proper education through handouts etc. The mathematical equation that is developed for the field observation does closely match with the Burgess model particularly for the highways. It is evident that HTV's are found to be in the traffic stream (Buses, trucks etc.) strict enforcement must be warranted for the operators to maintain the vehicles well particular in the all the junctions and midblocks. Road user's awareness should be organized which helps in reducing the noise levels as they can maintain their vehicles in a good condition.

IV. CONCLUSIONS

From the studies conducted and analysis performed, the following conclusions are drawn

i. At all the study stretches along Bangalore-Hyderabad National Highway 44, the measured noise levels are almost 35-50 percent higher than the prescribed limit for the residential area as these are located very close to the highway.
ii. Until & unless, the authorities take this issue on priority to kerb noise levels suggested in discussion, noise level would still continue to increase apparently.
iii. More periodic studies, road users and responsible citizens should take proactive participation in abating the noise levels at the places where the noise level due to road traffic has been a major concern.

From the studies, it reveals that the situation is alarming and probably other terms may also have this kind of similar problems. Hence a detailed and thorough studies is much demanded in the entire area with the greater depths.

V. References

1. Census of India 2011
2. Ratthapolsillapparasssamee, "*Predicting traffic noise model of Chalong-rat Expressway".* Mahidol university 2008.
3. Central Pollution Control Board "*Status of The vehicular Pollution Control Programme in India*" (Ministry of Environment & Forests,Govt. of India) East Arun Nagar, Delhi- 110 032 March 2010.
4. *"The Noise Pollution (Regulation and Control) Rules, 2000"* (The Principal Rules were published in the gazette of India, vide S.O. 123(E), dated 14.2.2000 and subsequently amended vide S.O. 1046(E), dated 22.11.2000, S.O. 1088(E), dated 11.10.2002, S.O. 569 (E), dated 19.09.2006 and S.O. 50 (E) dated 11.01.2010 under the Environment (Protection) Act, 1986.)
5. IRC: 04-1988, *"Guidelines for environmental impact assessment of highway projects"* jamnagar house, New Delhi.
6. ENVIS Newsletter State Environment Related Issues. *"Department of Forests, Ecology Environment, Government of Karnataka"* Vol No.4 November 2005.
7. ENVIS is a project of Ministry of Environment & Forests, Govt. of India. "*Department of Forests, Ecology and Environment, Government Of Karnataka"* special Issue, 2005.
8. Federal Highway Administration *"Interim noise standards for various types of land use",* April 1972.
9. Bhattacharya C.C Dr.Jain. S.S, Singh S.P, Dr. Parida.M & Ms.Namita Mittal "*Development of Comprehensive Highway Noise Model For Indian Conditions*" IRC 62-3.
10. Zekry F. Ghatass, "*Assessment and Analysis of Traffic Noise Pollution in Alexandria City, Egypt'*. World Applied Sciences Journal 6 (3): pp 433-441, 2009 ISSN 1818-4952 IDOSI Publications, 2009.
11. Al-Mutairi.N, Al-Rukaibi.F and Koushki.P "*Measurements and Model Calibration of Urban Traffic Noise Pollution*" American Journal of Environmental Sciences 5 (5): pp 613-617, 2009 ISSN 1553-345X, 2009 Science Publications.
12. Nelson.P.M, "*Transportation noise reference book*", Netherlands Health Council, 1987.
13. "*Traffic Noise Changes Frog Calls and Bird Song*" Royal Botanic Gardens Melbourne, pp 213-217, 2009.
14. Bhaven N. Tandel "*Urban Corridor Noise Pollution: A Case Study of Surat City*". pp 444-448, 2010.
15. Mahesh Chand & Anu P. Alex, "*Traffic noise prediction modeling & analysis for Thiruvananthapuram city*", Indian Highways, pp 56-60, March 2010.
16. M N Sreehari, "*Development of Vehicular noise contours for Urban Areas. A case study for Bangalore-India*" Journal of Andina Traffic, Columbia, Edition no.8, pp 84-90, 2011.