International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 11, November-2014

Study of Noise Levels at Traffic Density Areas in an Urban Environment

K. V. Dharmendra Kumar[1] , N. Srinivas[2]
Dept. of H&S, Vignana Bharathi Institute of Technology, Hyderabad[1]
Dept. of Environmental Studies, GITAM Institute of Science, GITAM University, Visakhapatnam[2]

***Abstract*: Noise is unwanted sound caused by human activities that are detrimental to quality of an individual. Continuous exposure to noise may induce physiological, psychological and behavioral changes. In the present study, an urban area of Secunderabad is selected as a case study to assess ambient noise levels generated by traffic. The average equivalent noise levels L_{eq} at different locations of Begumpet, a commercial area and Marredpally, a residential area are measured for a period of one month. The noise level indices (L_{10}, L_{50}, L_{90}) and Traffic Noise Index (TNI), Noise Climate (NC), Noise pollution Level (Lnp) were calculated. L_{eq}. at two study locations have reported higher values during peak hours along with all the other Indices (TNI and L_{nn}). The higher value is due to increase of vehicles. 2wheelers and 3wheelers are a major source of noise along with heavy vehicles. The calculated L_{eq} was predicted by using Calixto model and the regression between Observed and Calculated L_{eq} has shown good value of correlation coefficient (R^2) for both the study locations.**

1. INTRODUCTION

Noise can be defined as an unwanted or undesired sound. The unpleasantness and harmful effects of noise depend on factors like intensity of sound waves, frequency, time of exposure and intermittence or continuation of sound. The primary sources of noise in urban areas are the vehicles followed by industrial activities. The noise is caused by the accumulation of sound of vehicles in a traffic stream [1,2,3,4,8]. In India, Noise pollution in urban centers is gradually increasing over the years[13]. According to past surveys urban centers in India have revealed that noise levels are much higher than the prescribed standards [6,15,19,20]. This resulted that proportion of people exposed to noise is greatly increased and has direct and indirect affect to the people that can lead to the health hazard [14]. Some of the major health hazards caused by the noise as reported by
experts are hearing loss, blood pressure, muscle tension, migraine, headaches, irritability insomnia, increased aggression and psychological disorder [11,12,14]. In the present study urban areas of Secunderabad is selected as case study to assess ambient noise levels generated by traffic. The main purpose of this study is to monitor and calculate actual noise exposure levels to understand the problem and to develop database.

2. AREAS OF STUDY AND METHODS:

2.1 Study area

The city of Hyderabad is the capital of Telangana state and its twin city is Secunderabad which has a large population and more industries. The noise is due to urban agglomeration and industrialization.

2.2 Field Survey and Data Collection

Preliminary survey was conducted in two environmental backdrops of Secunderabad i.e. Commercial (Begumpet) and Residential (Marredpally) areas to assess the ambient noise levels generated by traffic. Fig. 1 shows the location map of the study area. Data were collected at two places for one month.

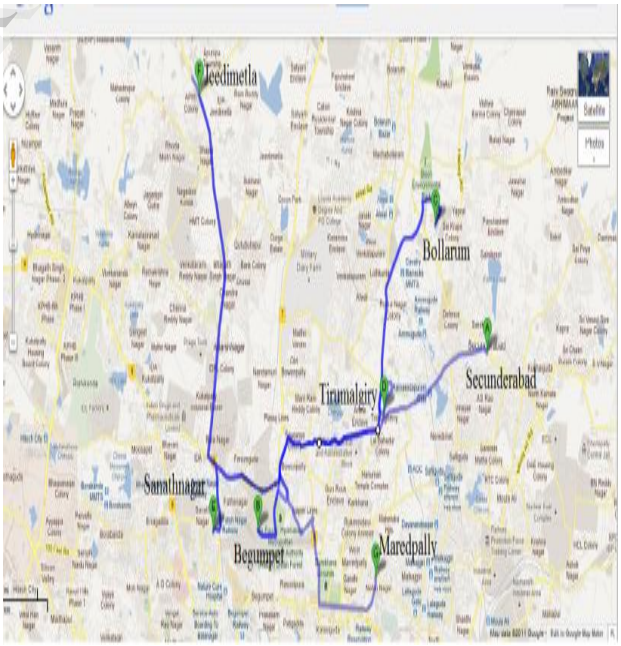

Fig:1 Shows different locations under Secunderabad

2.3 Different noise Indices used for study locations.

For this study the noise levels were measured at different locations of Begumpet which is a commercial area and Marredpally is a residential area under Secunderabad region. Traffic volume values are categorized as 2wheelers, 3wheelers, 4wheelers- Light vehicles and Heavy vehicles and noise levels were measured and diurnal (6:00am-5:00am) averages for each study location were measured

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for over a period of one month in June 2011. An Environmental sound level meter 2001(DL03) is used. It is used to measure the existing noise equivalent level (L_{eq}) dB(A) at the various intersections (locations). The battery operated instrument has a microphone, amplifier "A" weighting network and an indicating meter which gives a reading in db relative to $2x10^{-5}$ N/m^2.The reading range is divided into three limits 0-50db,50-100db and 100-150db .The display is alphanumeric type. We have used this instrument according to given standard conditions. The sound level meter was placed on a tripod strand at a height of 1.2 m from ground level at a distance of 5m from the road. The A- weighted sound pressure level was recorded at an interval of 1min for an hour and data were recorded in both peak and non peak traffic hours during day and night times which were used to compute equivalent continuous sound pressure level for one hour duration ($Leq_{(1hr)}$) dB(A). The noise measured noise levels exceeded for 10% of the time of measurement duration (L_{10}), the noise measured noise levels exceeded for 50% of the time of measurement duration (L_{50}) and the noise measured noise levels exceeded for 90% of the time of measurement duration (L_{90}) were also determined.

2.4 Indexing of traffic noise:

Three noise indices were measured viz., Traffic Noise Index (TNI) [16],Noise Climate (NC)[17],Noise pollution Level(Lnp)[18] were calculated to determine the extent of noise pollution for all hours.

Traffic Noise Index (TNI) is a parameter which indicates the degree of variation in a traffic flow expressed in dB (A)

$$TNI = 4*(L_{10}-L_{90}) + L_{90} - 30$$

Noise Climate (NC) provides the range over which the sound levels fluctuate in an interval of time and expressed in dB (A)

$$NC= (L_{10}-L_{90})$$

Noise pollution Level (Lnp) is also used to express varying levels of noise expressed in dB (A)

$$L_{np} = L_{50}+ (L_{10}-L_{90})^2/60 + (L_{10}-L_{90})$$

2.5 Statistical analysis:

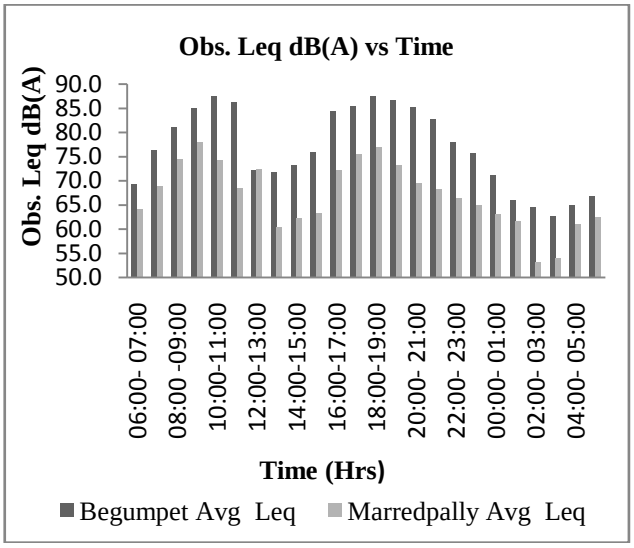
A regression equation were developed between Observed L_{eq} and Calculated L_{eq} to determine R^2 value using Calixto model[5] which is best suited for Indian road conditions.

3. RESULTS AND DISCUSSION:

3.1 Noise levels L_{eq} dB (A) at study locations

At the study location of Begumpet which is a fast growing commercial area the average L_{eq} i.e. continuous noise equivalent levels shows an average value of 76.7 dB (A) L_{eq} for 24 hrs and shows a minimum value of 62.7 dB (A) and a maximum value of 87.6 dB (A).Whereas for the residential area of Marredpally shows an average value of L_{eq} 67.1 dB (A) for 24 hrs and its minimum and maximum values of average noise levels $L_{eq(1hr)}$ are 53.2 dB (A) and 78.0 dB (A) respectively. From the analysis it was observed that the noise levels were high above the prescribed limits during peak hours of morning and evening hours at all the study locations as given by CPCB (Central Pollution Control Board) of India, 2000 as shown in Fig: 3.

Fig: 3 Ambient Traffic noise levels at study Location Vs Time



3.2 Noise Indices Analysis

The average values of all Indices such as L_{10}, L_{50} and L_{90} along with the different parameters such as TNI, NC and L_{np} were studied for 24 hrs at all the study locations is shown in Fig: 4. The average L_{10} values for 24 hrs shows an maximum for commercial area of Begumpet and a minimum of 70.2 dB (A) for the residential area of Marredpally whereas L_{50} and L90 shows a minimum value of 63.8 dB (A) and 56.7 dB (A) respectively for Marredpally.

Traffic Noise Index (TNI) values were computed to estimate the annoyance response due to traffic noise and the value of TNI over 74dB (A) is defined as the threshold of over criterion [16] and also depends upon the different noise indices. The TNI values also showed high values with the maximum value of 95.1 dB (A) for Begumpet and minimum value is 80.7 dB (A) for Marredpally. These high average values of TNI for all study locations show the annoyance that is caused by traffic noise.

The Noise Climate (NC) provides the range over which the sound levels fluctuate in an interval of time and expressed in dB (A) which also depends upon noise indices. The average noise pollution level L_{np} which gives varying levels of noise has a maximum value of 92.4 dB (A) for Begumpet and Marredpally has a minimum value of 80.3 dB (A).

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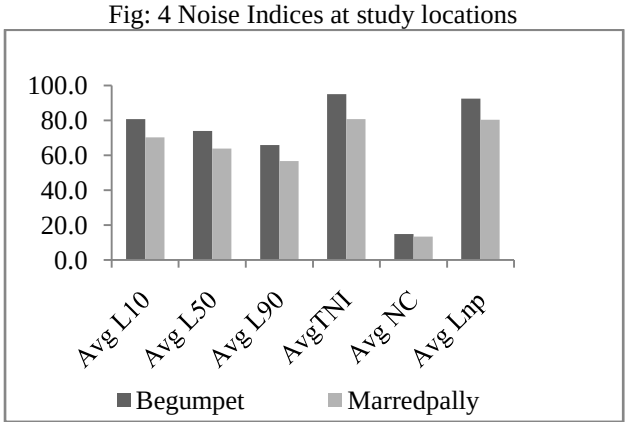
Fig: 4 Noise Indices at study locations



3.3 Mathematical model:

The vehicle flow is the sum of Light and Heavy vehicles flow that passes at a road during certain time duration. As the heavy vehicle generates a
stronger noise compared to lighter vehicles. A factor 'n', has been considered for such vehicles ,so that an equivalent value can been achieved for the traffic flow Q_{eq} , by considering Q as the real hourly vehicle flow, VP as the percentage of heavy vehicles and 'n' as the weighting factor , we get

$$Q_{eq} = Q(1+n*VP/100) \quad (1)$$

So the term, 10log (Q_{eq}) will be transformed into 10log [Q(1+n*VP/100)].

The values of 'n' vary from 4 to 10 that can used to find the largest correlation coefficient between the observed and calculated L_{eq}.

Once the vehicle flow Q, the percentage of heavy vehicles, VP, the value of 'n' is determined we can calculate the noise equivalent level L_{eq}. In our study the value of n=9.5 gives the highest correlation between the values of Observed L_{eq} and 10log [Q (1+n*VP/100)] have been plotted on a graph, a curve has been adjusted to the measured points.

Mathematically, the curve can be represented by

$$Y=a*x+k \quad (2)$$

By applying the variables on the straight line equation, we get

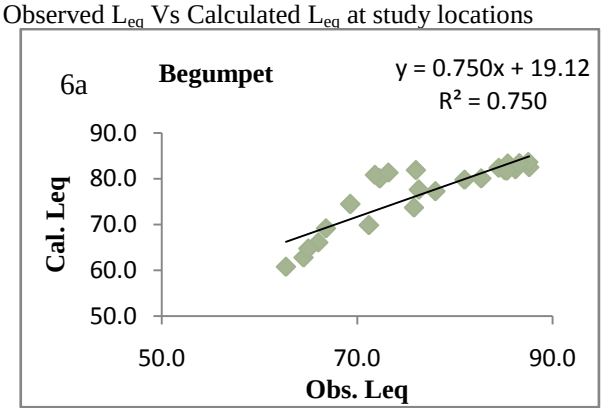
$$L_{eq} = a*10\log [Q (1+9.5*VP/100)] +k \quad (3)$$

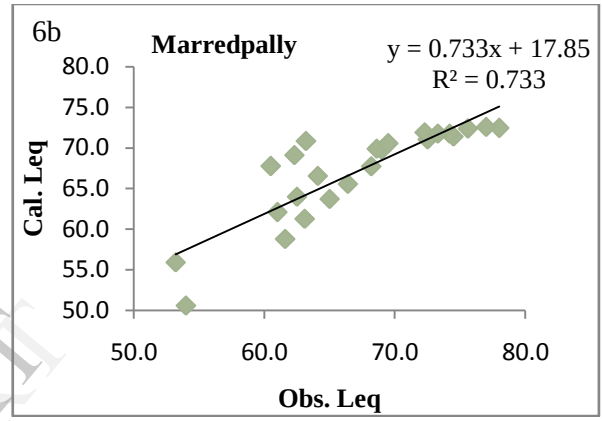
The values of constants 'a' and 'k' can be found after the statistical methods of linear regression have been applied.

The Mathematical modeling for predicting the equivalent noise levels L_{eq} generated by road traffic was done by earlier researchers by using statistical methods of linear regression.

3.4 Model Validation:

Observed L_{eq} Vs Calculated L_{eq} at study locations





From the above Fig: 6(a –b) it is evident that a strong correlation coefficient (R^2) was found between the Observed L_{eq} and Calculated L_{eq}. The R^2 values the commercial area of Begumpet showed a value of 0.7507 and the residential area of Marredpally showed the least value of 0.7337..

4. CONCLUSIONS

The average equivalent noise levels L_{eq} at study locations of Begumpet, a commercial area, Marredpally,a residential area, under Secunderabad region are studied for a period of one month. The monthly variations of averaged noise levels L_{eq} taken diurnal for all study locations showed high values during peak hours along with all the other indices (L_{10},TNI and L_{np}). Increases of vehicle flow of all types i.e. 2wheelers and 3wheelers are a major source of noise along with heavy vehicles.

The usage of more number of personal vehicles and inadequate public transport leading to frequent traffic jams is one of the major sources noise. The variations of observed and calculated L_{eq} showed a good value of R^2 at all study location. Traffic noise can be reduced by increasing mass transport, plantation of trees, awareness programs.

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