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A Study on Captivated Capacity of Noise Due to the Designed Models and Damping Materials

V. N. Shailaja[1]*, B. Ravishankar[1] and B. E. Narkhede[2]

[1]Department of Industrial Engineering and Management, BMS College of Engineering, Bull Temple Road, Basavanagudi, Bengaluru - 560019, Karnataka, India; rajvns1@gmail.Com
[2]Department of Production and Industrial Engineering, VJTI Matunga, H R Mahajani Marg, Matunga, Mumbai - 400031, Maharashtra, India

Abstract

Noise is generated virtually by all processes. It is identified as an important pollutant. It causes discomfort to human beings and affects society too. This aspect has attracted many researchers to carry noise based research in urban environments. This paper attempts to establish data of various noise sources in Bangalore city, India. The study investigates various models and materials which exhibits absorption properties. The aim is to identify the best model and material which can help develop a good noise solution. Sustainable materials are also being used. Experiments are conducted using simulated noise conditions and on live engineering process. Materials exhibited varying damping properties with respect to ambient parameters. The experiments witnessed utilization of sound level meters and also 4 channel noise analyzer (4CNA). Noise data gathered are analyzed through tabulated results and meaningful graphs. Scientific analyses are made on the noise absorption properties of materials. The findings will augment engineering solutions for household and industries. Furthermore the study addresses the analyses of the stress levels of human beings due to various inputs.

Keywords: Ambient Noise, Barriers, Damping Materials, 4CNA, SL4010

1. Introduction

Noise is known as discarded sound, and is subjective. Human perception of noise is influenced by physical, physiological and psychological factors. Physical factors include the sound pressure level at the position of the listener, physiological factors include the sharpness of hearing, and psychological factors include familiarization to steady noise and the activity that an individual is undertaking while the noise is present. Sound abide variations disseminate to human ear as rapid vibrations in air pressure that can be expressed precisely. A variety of statistical indices are used to quantify noise in different situations.

(i) Ambient Noise Level: General environmental noise from commercial, industrial or unidentified sources is often expressed in terms of the equivalent continuous sound pressure level over the time period of interest (LAeq,T). This is the notional continuous constant noise that contains the same sound energy over the period of interest as the actual fluctuating noise. This is not an 'average' sound level over a period, but the concept has some similarities and provides a single figure quantity that can be used to compare noise levels which fluctuate with time.

(ii) Background Noise Level: The LA90,T index identifies the noise level exceeded for 90% of the period of interest, and provides a good indication of the background noise level that remains in a location in the absence of any easily identifiable sources.

(iii) Maximum Sound Level: The maximum sound level (LAmax) is the highest time-weighted sound level measured during a period. The time constant of the measure may either be fast (125 ms), slow (1 s) or impulsive (35 ms), and it is usual to identify the time

**Author for correspondence*

constant in the notation – e.g. LAFmax indicates that the maximum sound level was measured with the fast time-weighting. The longer the time constant over which the measurement is integrated, the greater the smoothing effect of the time-weighting, which gives a lower numeric value of the measurement.

(iv) Road Traffic Noise: This traffic noise has a strong low frequency content and is often more steady over the course of a day than other sources of environmental noise.

2. Problem Identification

Noise and its effects in real world scenario is a major problem. It causes discomfort to human beings and affects society too. This aspect has attracted researchers like us to carry noise based research in urban environments and city (Bengaluru, Karnataka- India). Due to the increase in the population of Bangalore city, there has been an increase in the number of vehicles, Industries, domestic items etc. These things have gradually resulted in the increase of noise levels in the city. People are getting affected by high level noise. The effects of high level is unbearable, it causes a high level of discomfort and annoyance. Problems of high level noise does hit all the places like industries, hospitals, houses, schools, offices and all major places. Hence there is a need to study and analyze about the noise levels in the city and also about the sources which are causing it. At many places in Bangalore city, the high level noise is inevitable. A particular solution is yet to be initiated. Hence suggestion was taken to come out with effective models which can at least absorb the noise level to a certain extent though it cannot be eliminated completely by considering various dampening factors and through tabulated results and meaningful graphs. These findings augment engineering solutions for household and industries. Furthermore the study addresses the analyses of the stress levels of human beings due to various inputs.

3. Objective

The study was carried out by identifying various noise sources in different places.

- To make an attempt to absorb noise in higher noise level sources by using various models.
- To use different dampening materials in these models in order to make an attempt to absorb noise effects from these noise sources.
- To analyze the data using statistical tools to infer the sources having higher and lower noise levels and to observe percentage of noise absorption.

4. Data Collection and Experimentation

Around one lakh data was collected from various sources. The sources included bus, lorry, car, jeep, 2 wheelers etc. Manual questionnaires and online surveys were also adopted. The outcomes were derived and discussed. Various models were designed and developed. All designs were analyzed to be more efficient in terms of noise reduction, light intensity, flow of air, cost and design. Hence wooden prototypes of those designs were developed in order to reduce the high level noise sources. The data was analyzed by considering two models namely, Model 1: Louvers Model and Model 2: Tapered Model.

The experiment was performed to test the noise flow and control of sound waves. It was performed in Hawthorne study center at Industrial Engineering/Quality Assurance and Reliability Lab of Industrial Engineering and Management Department of B.M.S College of Engineering. The purpose of selecting this place was to eliminate various other additional noise sources. Wooden model is kept inside the closed cabin, so the other sound waves will not be merged with sound waves which are supposed to be used for testing. Here the polystyrene will act as barrier. To execute sound capacity when further structural systems/surroundings and peripheral reverberation sources are at a slightest level and will not influence measurements of paraphernalia being tested. In order to restrain other reverberation sources, the following suggestions were considered:

- A closed room for testing.
- Then at four different sources the sensors were kept to track the noise.
- Switch off other paraphernalia in the surroundings that might impede with testing.
- Note the recordings of sound levels.

5. Data Analysis

The following below table represents the average noise level at all the regions i.e Bangalore north, south, east, west, and central region by considering 24 hours which specifies an overall analysis.

Table 1. Average noise level of all regions of Bangalore city

Zones	Average noise level in dB
North	69.05
East	64.72
Central	72.49
West	55.88
South	66.35

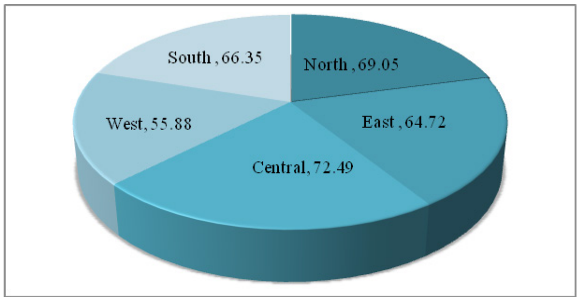


Figure 1. Overall representation of noise levels in Bangalore city

Based on the data that have been collected it was found out from various other noise sources traffic noise was contributing more for noise pollution and also from the survey which we conducted we found out that traffic noise created more impact on human beings, so by considering only traffic noise as a noise study parameter we have tried to develop a mathematical model.

As people who stay nearby to road highways, get their health affected by high level of noise caused by busy traffic. Therefore to protect people from noise exposure from the busy traffic near highways desirable models can be predicted to minimize the noise level near highways. The noise level near Nelmangala road of Bangalore city at toll plaza was determined and the noise impingement measure for various land users near to highways are as given below

Land Use	dB
Residential	65dB
Commercial	70dB

If the noise level crossed beyond the above mentioned decibels of the land users, the blood pressure of the people living nearby gradually rises. According to above situation the model includes traffic flow (vehicle/hour), traffic speed (Km/hour), traffic composition in terms of heavy vehicle (%) were analysed. Regression analysis of noise level (dB) on speed was carried out for different sources based on Logarithmic relationship i.e.

$$NL = p \log(speed) + q$$

Where p and q are constants and their values differ for each type of vehicle.

6. Traffic Noise Measurement and Study Area

At Sondekoppa junction when traffic flow was mild, average and heavy the capacity of noise level was conducted by using sound level meter at various hours of the day (8am-9:30am; 11am-12:30pm; 2pm-3:30pm; 5pm-6:30 pm). Traffic flow was expressed as vehicle per hour, average traffic speed was expressed as kilometre per hour and traffic composition was expressed as percentage of heavy vehicles. The readings obtained using sound level meter at different locations are as tabulated below:

Table 2. Measured Noise Levels at different locations

Sl.no	9am	12pm	2pm	6pm	Average
1	73.2	75.8	73.4	80.6	75.75
2	76.9	70.4	73	83.2	75.88
3	78.1	70.7	71.4	80.7	75.22

7. Analysis of Data and Model Development

From the data collected and applying the basic noise level from the above study the traffic noise model was developed. By using the below equation the Noise Level (NL) is determined.

$$NL = 10\log T_f + 33\log\left(A_v + 40 + \frac{500}{A_v}\right) + 10\log\left(1 + \frac{5P_{hv}}{A_v}\right) - 26.6 \quad \text{(a)}$$

Where: T_f = Traffic flow, P_{hv}= Percentage of heavy vehicle, A_v = Average speed of vehicles

8. Calculations

Sl no1:

$$NL = 10\log T_f + 33\log\left(A_v + 40 + \frac{500}{A_v}\right) + 10\log\left(1 + \frac{5P_{hv}}{A_v}\right) - 26.6$$

= 10 log(421) + 33 log(80 + 40 + 500 / 80) + 10 log(1 + 5*52.019 / 80) +26 .6

=75.26 units

Sl no2:

$$NL = 10\log T_f + 33\log\left(A_v + 40 + \frac{500}{A_v}\right) + 10\log\left(1 + \frac{5P_{hv}}{A_v}\right) - 26.6$$

= 10 log(426) + 33 log(80 + 40 + 500 / 80) + 10 log(1 + 5*46.478 / 80) +26 .6

=75.19 units

Sl no3:

$$NL = 10\log T_f + 33\log\left(A_v + 40 + \frac{500}{A_v}\right) + 10\log\left(1 + \frac{5P_{hv}}{A_v}\right) - 26.6$$

= 10 log(434) + 33 log(80 + 40 + 500 / 80) + 10 log(1 + 5*52.534/ 80) +26 .6

=75.42 units

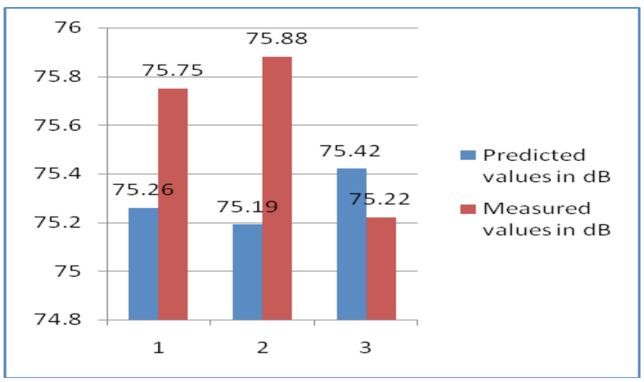


Figure 3. Comparison between predicted and measured value.

Table 3. Variation in predicted value and measured values

Sl no	Predicted values in dB	Measured values
1	75.26	75.75
2	75.19	75.88
3	75.42	75.22

The above table represents the percentage of absorption of noise with and without models and also using various damping materials. It is observed that after various analysis the model with honeycomb showed 16.3% absorption.

Interpretations: Damping materials used: with cotton, sponge, paddy husk, coir, honey comb.

Sl. no	Type of model used	Damping material	Noise in dB	% reduction in noise level
1	Pipe drilled model- PVC pipe being used	Honey Comb	84.8	6.7%
2	Curvilinear type model- sheet metal being used	Honey Comb	83.58	8.4%
3	Curvilinear type model- aluminium foils being used	Honey Comb	83.03	9.1
4	Laminar flow type model	Honey Comb	81.44	11.2%

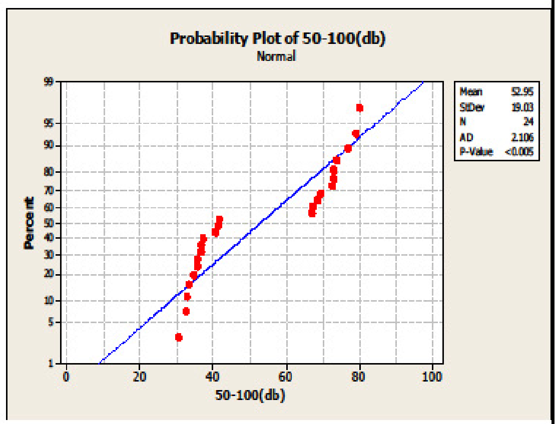
Table 4. Different Dampening Materials are used both with and without model

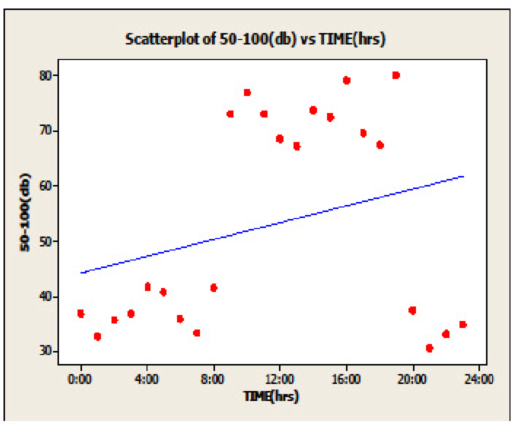
Without Model	Model Without Any Material	With Cotton	With Honeycomb	With Paddy Husk	With Sponge	With Coir
90.6	80.5	79.6	77.8	79.9	78.7	78.4
90.6	79.9	80	78	80	78.6	78.6
90.6	80.1	79.6	77.9	79.8	78.6	78.8
90.6	80.4	79.8	77.6	79.8	78.9	78.8
90.6	80.5	79.9	77.6	79.8	78.7	78.6
90.6	80.5	79.9	77.9	80.1	78.8	78.5
90.6	80.3	79.3	78.1	80	78.8	78.6
90.6	80.2	79.6	77.8	79.9	78.5	78.8
90.6	80.4	79.8	77.7	79.9	78.6	78.9
90.6	80.4	79.8	78.1	79.9	78.8	78.4
Average	80.32	79.73	77.85	79.91	78.7	78.64
% reduction	12.7	13.6	16.3	13.3	15.1	15.2

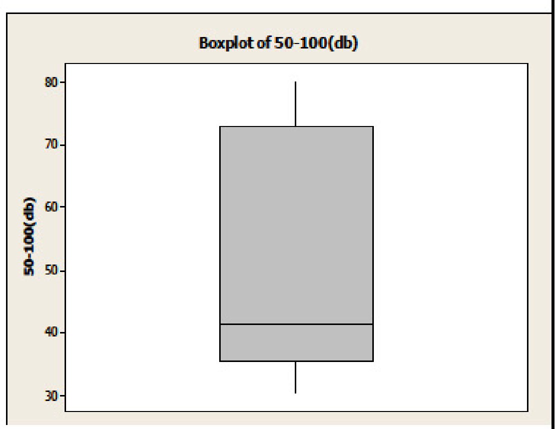
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT

PROJECT TEAM				
ABHIJAY PRAKASH	EQUIPMENT USED	SL4010	DATE OF ANALYSIS	10/04/15
B S SHREYAS	MAXIMUM DB RANGE	80db	PLACE OF CONDUCT	BANGALORE
CHIRAAG U	MINIMUM DB RANGE	30.6db	AREA	18TH CROSS CORPORATION
SATTU ASHWINEETH	RANGE	50-100 db	ZONE	WEST

TIME	35-80	50-100	80-130
00:00	38.6	36.7	34.3
01:00	33.6	32.7	37.4
02:00	34.7	35.7	33.1
03:00	41.2	36.7	38.7
04:00	34.4	41.6	38.1
05:00	30.6	40.7	33
06:00	35.8	35.8	38.5
07:00	37.4	33.3	38
08:00	41.4	41.4	37.1
09:00	70.7	73	71.2
10:00	71.9	76.9	67.5
11:00	72	73.1	74
12:00	72.8	68.5	71.8
13:00	67.4	67.1	79
14:00	70.5	73.7	66.7
15:00	65.9	72.5	72.1
16:00	76.2	79	67.7
17:00	77.5	69.5	75.1
18:00	76.2	67.3	73.4
19:00	68.4	80	76
20:00	34.9	37.3	35.7
21:00	34.1	30.6	31.9
22:00	42	33	36
23:00	32.1	34.8	33.2







CONCLUSION

- Scatter is spread largely over the mean.
- Peak time average value = 69.82db
- Standard deviation is also high (>30%)
- Hence situation calls for an effective **engineering design, analysis and work.**
- Projected db value after engineering design should be 43.68db (ideal).

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5	Combined louvers model	Honey Comb	77.85	16.3%

Discussion on Results

- The mean and standard deviation for the readings without model is 92.74 dB and 1.562192 respectively and for the readings with model is 91.71 dB and 1.575824 respectively.
- This indicates a variation in noise level up to 1.3 dB between with and without model which is approx. 1.2% decrease in noise level.
- Whereas the test readings for model attached with paper and wet paper shows a mean and standard deviation of 85.7 dB and 1.862495 and 85.08 dB and 1.99097 respectively which indicates a drastic decrease in the noise levels.
- While using dry and wet fruit crates the noise level were decreased drastically with mean and standard deviation 77.92 and 2.40037 and 78.94 and 0.552167.
- With the usage of foam the noise level weren't decreased as compared to other dampeners used with mean and standard deviation 86.5 and 2.146832.
- Noise level is high, in machine shop with machines ON.
- When mixed sources were considered, Ganesh Chaturthi celebration showed maximum variation.
- When buildings were taken into consideration it was found that construction site was much above the average noise level.
- Compared to all of the above mentioned sources noise level in the construction site has the highest variation affecting human health.

9. Conclusion

After considering various models like Pipe drilled model, curvilinear, laminar, louvers and Combined louvers model along with various damping materials like cotton, sponge, paddy husk, coir, honey comb, it is seen that by using honeycomb the percentage of noise level was reduced in all of the models. The maximum reduction was 16.3% by using combined louvers model along with honeycomb as the damping material. Therefore the designed and developed models have proved to be effective in reducing noise levels.

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