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A Study on Sound Level Attenuation and Assessment of Ambient and Traffic Noise Levels

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ABSTRACT
The adverse impacts of increased noise can range from hearing loss to loss of concentration and increased blood pressure etc. A study is conducted near Vijayawada in Andhra Pradesh to determine the ambient and traffic noise levels. Sampling is carried out for two days at four different locations identified based on locational significance. The noise levels are within the limits in silent and residential areas but exceeding in commercial and industrial areas. Traffic noise is determined at two busy locations representing Industrial and Commercial zones in Vijayawada for two days. Sampling is done on working and non-working days to assess the variation in the noise levels. Approximately 50% reduction of vehicle flow is noticed on non-working days but only a 2dB reduction is noticed. This shows the extent of traffic noise in these areas irrespective of working or non-working days. Experiments are conducted in the lab to determine the sound attenuation of various absorbing materials such as wood, cloth, glass, plastic, thermocol etc. A maximum reduction of 36% is noticed for a combination of thermocol + wood + Cloth + Metal on a table. This information will help in assessing a suitable combination of absorbents when designing for noise reduction from point sources.

Key words: Noise attenuation, absorbing materials, ambient noise, traffic noise

I. INTRODUCTION

Noise is one form of sound that creates disturbance. It causes significant adverse impacts such as annoyance, sleeplessness, heart related problems, loss of work efficiency etc. (Debashish et al., 2012, Mishra et al., 2008, Mondal, 2013). The adverse impacts are similar on both male and female population and different age groups of the population (Mondal, 2013). Noise can be classified as Ambient, which is from the surroundings and Traffic Noise, which is generated from the vehicles. The ambient noise depends mainly on the domestic, commercial and day-to-day activities around us (Garg, 2014). The Traffic noise depends on several aspects such as location, vehicle flow per hour, time of the day, type of vehicles, vehicle condition, pavement condition, geometric design of pavement, vehicle specifications, barricades around the pavement etc (Ramakrishna et al., 2017, Ramakrishna et al., 2019, Ramakrishna et al., 2021, Marathe, 2012). The noise from the vehicle varies with the distance from the vehicle to the sampling location and bears a significant relation with increased distance (Ramakrishna et al., 2021).

The prescribed limits in India (CPCB, 2000, Ramakrishna et al., 2017) for the ambient noise are defined for four specific zones such as Residential, Commercial, Industrial and Silence areas. The population is mingled in many urban areas and are even have their houses and establishments located in Commercial and Industrial zones due to their personal needs and demands. They are exposed to the expected high noise levels in these zones. The regions around the airports, bus stations and railway stations are also being surrounded by habitat zones as a part of real estate development. Hence, it is essential to study the ambient noise in such locations. High noise levels are reported (Anurag et al., 2013, Kavita, 2014, JulleMelne et al., 2013) near the bus station and railway station regions due to the heavy traffic by the 2-, 3- and 4-wheeler population.

The ambient and traffic noise levels in and around Vijayawada are becoming a concern (Ramakrishna et al., 2017, Ramakrishna et al., 2019, Ramakrishna et al., 2021) due to the increased vehicular traffic as a result of State bifurcation and close proximity of capital city near Vijayawada. The city is geographically located at a prime location which has a good access to the rail, road, and air networks of transportation. It is having good facilities in terms of educational, commercial, medical and recreational aspects. Further, the migration of population from the nearby villages using the available transportation modes makes vehicular traffic increased during working days. Two major fly-overs, connecting NH-65 and NH-16 are in operation in the city for the last two years to reduce traffic congestion problems. The towns and cities close to Vijayawada have noticed

increased traffic flow due to the day-to-day movement of people to Vijayawada for the medical, educational, industrial, commercial, employment and government related activities.

The present study focuses on (i) the study of the ambient noise levels at all representative locations under the four zones during Feb-April 2022 (ii) the traffic noise at selected locations using the relevant noise quality parameters. (iii) the study of a combination of noise absorbers to determine the noise attenuation from a point source. This information will help in developing the noise reduction barriers, either alone or in combination for noise reduction.

Study area:

Four different sampling zones in and around Vijayawada are selected based on their locational significance. They are Residential zone (in Nuzividu), Commercial zone (Besant road in Vijayawada), Industrial zone (NTTPS Road, Kondapalli), Silent zone (DR College Road, Nuzividu). Nuzividu is a town and has a close proximity to Vijayawada. It is a very busy area due to the educational, residential and commercial activities in the town. People will be traveling to and fro from Nuzividuto Vijayawada for their livelihood and business needs.

The Residential and Silent zones are selected in Nuzividu, due to the presence of closely located residencesand schools in that region. The Commercial and Industrial zones are selected in Vijayawada. The Besant road is one of the busiest commercial areas in Vijayawada and hence considered as Commercial zone. Kondapalli houses a large group of industries along with industrial estates including DrNarlaTatarao Thermal Power Station (NTTPS) and is located around 25 km from Vijayawada.

To assess the impact of traffic noise, the traffic noise at two locations, Bhavanipuram(Commercial zone) and Autonagar(Industrial zone) in Vijayawada on two days (working day and non-working day), is also determined and analyzed based on traffic noise parameters.

II. METHODOLOGY AND TOOLS USED

The ambient noise levels at each of the locations are measured for every 2 minutes in a 2 hour sampling period. The overall sampling is carried out for a total of 8 hours (7am to 9am, 10 am to 12 Noon, 1pm to 3pm, 4pm to 6pm) per day. The data collection is done for two days at each location to verify the closeness of the values. A digital sound level meter is used for measuring the noise levels.

The ambient noise quality parameter such as Equivalent sound level (Leq), Noise Climate (NC) and average sound level (Lavg) are determined using the equations 1-3 (Garg, 2014, Ramakrishna et al., 2017). The Traffic noise levels are computed using equations 4-9 (Swain and Goswami, 2013).

Leq=L50+0.018$(L10 - L90)^2$---------- (1)

NC = L10-L90---------- (2)

Lavg = $20 \log_{10} \left[\frac{1}{N}\sum_1^N (10)^{\frac{Li}{20}}\right]$---------- (3)

Traffic Noise Index, TNI = 4 (L10-L90) + L90 – 30 dB (A) -------- (4)

NC = L10 – L90 --------- (5)

Leq = L50 + 0.018 $(L10 – L90)^2$ ---------- (6)

where, L10 = 61 + 8.4 Log (Q) + 0.15P – 11.5 Log (D) ---------- (7)

L50 = 44.8 + 10.8 Log (Q) + 0.12P – 9.6 Log (D) ---------- (8)

L90 = 39.1 + 10.5 Log (Q) + 0.06P – 9.3 Log (D) ---------- (9)

Where,Q: Total vehicle flow per hour, P: % of heavy vehicles, D: Distance from source to receiver.

III. RESULTS AND DISCUSSION

The ambient noise levels obtained during the sampling are compiled for Day-1 and Day-2 at each location and are shown in Fig. 1-4. It can be noticed that, the trends of noise levels on each of the days are similar without much deviations.

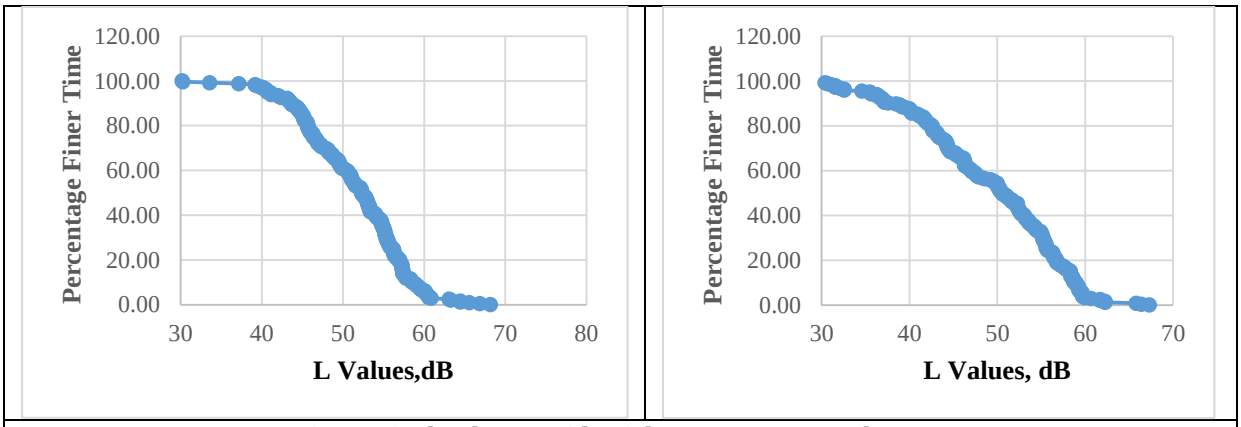


Fig.1 Noise levels at Residential zone on Day-1 and Day-2

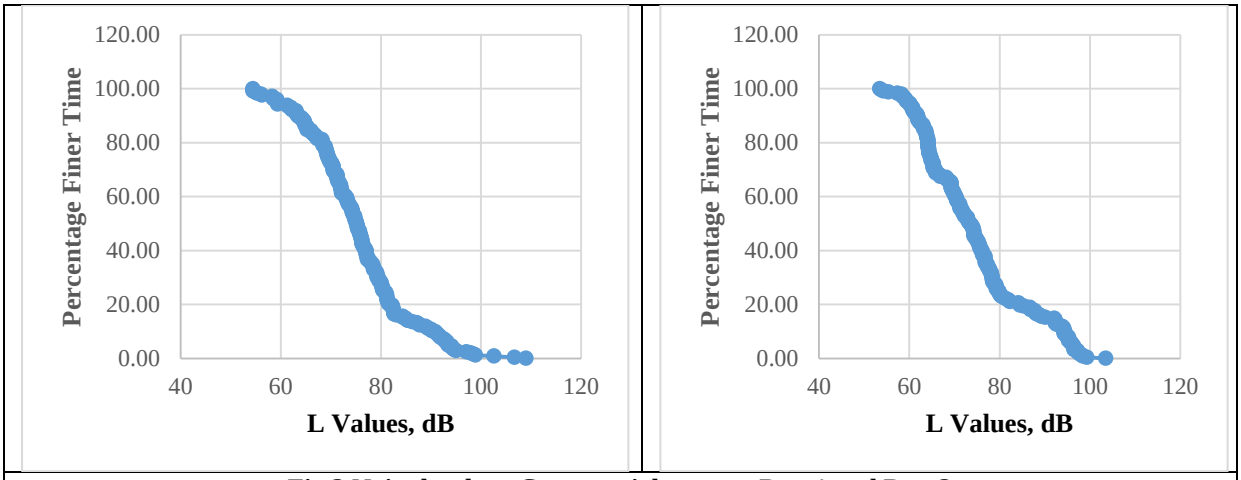


Fig.2 Noise levels at Commercial zone on Day-1 and Day-2

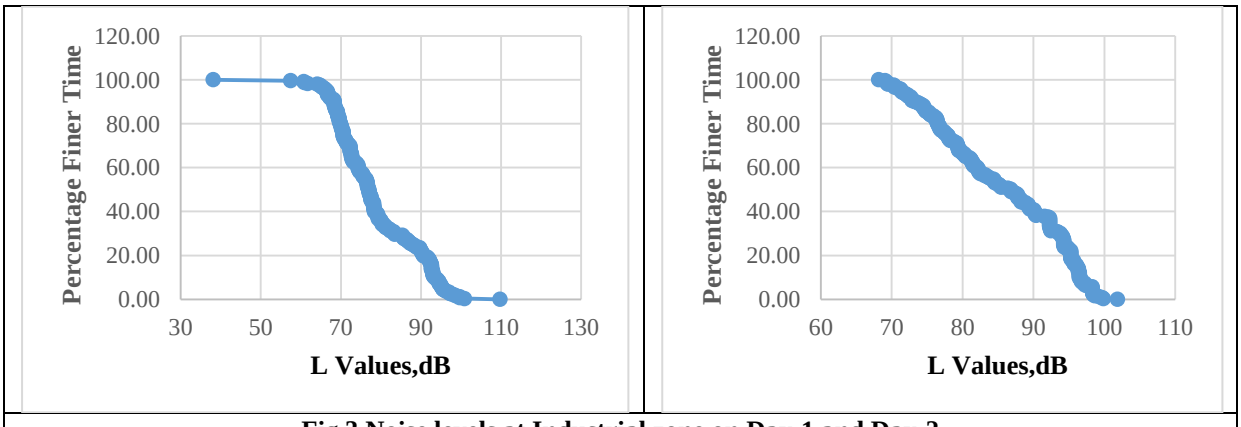


Fig.3 Noise levels at Industrial zone on Day-1 and Day-2

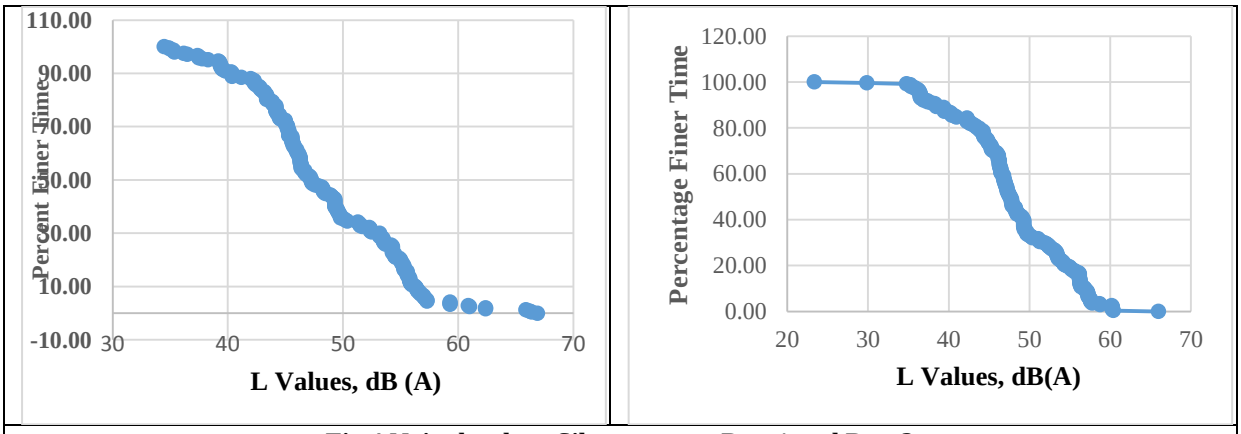


Fig.4 Noise levels at Silent zone on Day-1 and Day-2

The Leq and Lavgvalues at each of the locations are computed using Equations 1-3 and given in Table-1. It is noticed from the results that, the Leq and Lavg values are also similar at each of the locations on a particular day. However, the Leq values are more reliable than Lavg as Leq considers L10, L50, & L90 values computed from the Figures 1-4. The L10, L50, L90 values represent the percent sound level finer during sampling time. L10 represents sound levels greater than 10% of the total sampling duration and so on. The difference between l10 and L90 denotes the Noise climate, which represents the background noise in the region during the sampling duration. It is also observed from Table-1 that, the sound levels except at Residential and silent zones are exceeding the permissible limits. This shows the sound levels are relatively high in Vijayawada surroundings rather than at Nuzividu. This indicates that Nuzividu is relatively calm area compared to the Vijayawada city, which is always busy due to its close proximity to the state capital.

Table-1: Ambient noise levels at the sampling locations

S.NO	Sampling zone	Sampling details	Leq dB(A)	Lavg dB(A)	Permissible Limits dB(A)
1	Residential area	DAY 1	56.15	53.61	55 dB(A)
2		DAY 2	50.95	52.60	
3	Commercial area	DAY 1	87.52	82.36	65 dB(A)
4		DAY 2	91.56	82.84	
5	Industrial area	DAY 1	87.76	85.22	75 dB(A)
6		DAY 2	85.44	89.82	
7	Silent zone	DAY 1	51.51	50.97	50 dB(A)
8		DAY 2	51.06	50.45	

The Traffic noise levels are collected from two locations, Bhavanipuram and Autonagar, two of the busiest areas in Vijayawada. The sampling is carried out in two days. To understand the difference in the noise levels, one working day and another non-working day are considered. The calculations are made using Equations 4-9. The results are consolidated and given in Table-2.

Table-2 Results Obtained on the Working &Non-Working Daysat the sampling locations

Location	Sampling period	Traffic Noise parameters				
		P	Q	TNI	Leq	NC
Bhavanipuram	**Working day**	17.62	1441.75	94.37	76.33	14.86
	Non-Working day	25.56	664.63	97.03	74.46	16.29
Autonagar	**Working day**	17.33	1354.75	91.7	74.54	14.59
	Non-Working day	23.33	681.5	93.57	72.67	15.75

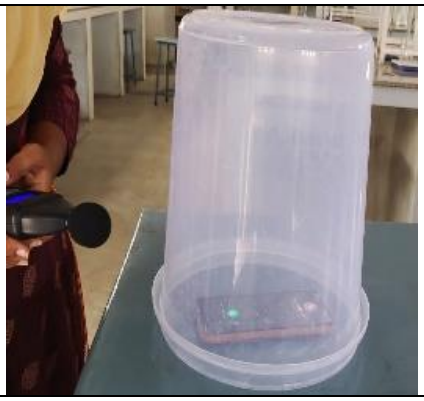
It is observed from Table-2that, the vehicle flow (Q) in these locations is double from that during non-working days. However, the noise levels are marginally reduced by 2 dB from working to non-working days. This indicates that the areas selected are very busy even on non-working days. The sound levels at Commercial zone are high and are more close to the limits prescribed under Industrial zone. The difference in the NC values are also consistent indicating the sound levels are almost uniform at these locations on the days of sampling.The sound level reduction is very marginal despite 50% reduction in the vehicular traffic indicating the busiest nature of traffic at these locations.

Sound reduction using various absorbing materials

The need of the hour is to reduce the sound levels from the various sources generated. The sound emitting source should be enclosed in an enclosure comprising of different materials and sound reduction should be computed. This will help in identifying measures to be taken to reduce sound levels at residential, commercial, silent or other areas to bring down the sound levels below the permissible limits.

Different enclosures are attempted in individual and in combination, in the lab to determine the sound reduction due to the absorbing materials. The sound source is kept on floor, on table, covered with enclosures such as glass, plastic, wood, thermocol(polysterene) etc. to study the sound reflection and absorbing levels during the experiment. A thick cloth is also used as insulation material and to absorb the vibrations of the sound source. Different absorbents are used in combination with the cloth. Few typical combinations of the experiment are shown in Fig.5.

(a) Glass enclosure on table



(b) Plastic bottle enclosure on Table

(c) Wooden box + Cloth enclosure

(d) Plywood + Thermocol + Cloth enclosure

Fig. 5 Different absorbing materials used as enclosures in sound reduction

The percentage of the sound reduction is computed and given in Table-3. The results show a maximum sound reduction of 36.24%, 27.63% and 25.17% for the three major modes of combinations used in the experiments. Glass container overlain over the sound source reduced sound by 25%, cloth + Plywood+ Thermocol reduced sound by 27%, Thermocol + Metal + Cloth + wood reduced sound by a maximum of 36%. This study is useful in designing enclosures for point sources emitting sound in the atmosphere particularly from industry or residential sources.

Table-3Percentage of Reduction of sound levels using combinations of absorbing materials

S No	Item Description	Sound reduction, dB	% of Reduction
1	Glass Container On Floor	21.8	24.38
2	Glass Container On Table	22.5	**25.17**
3	Plastic Container On Floor	18.8	21.03
4	Plastic Container On Table	11.6	12.98

5	Wood On Floor	10.5	11.74
6	Wood On Table	5.1	5.70
7	Thermocol On Floor	14.8	16.55
8	Thermocol On Table	11.7	13.09
9	Metal On Floor	22.1	24.72
10	Metal On Table	18.3	20.47
11	With Cloth Plywood Insulated With Thermocol On Table	22.8	25.50
12	With Cloth Plywood Insulated With Thermocol On Ground	24.7	**27.63**
13	Thermocol+wood+metal On Ground	20.5	22.93
14	Metal + Cloth On Table	3.2	4.36
15	Metal + Cloth On Ground	10	13.62
16	Wood + Cloth On Ground	5.9	8.04
17	Wood + Cloth On Table	8.1	11.04
18	Thermocol +glass + metal On Table	15.5	21.12
19	Thermocol + glass + metal On Ground	16.6	22.62
20	Thermocol +cloth + Metal + wood On Table	26.6	**36.24**
21	Thermocol + cloth + wood On Ground	23.2	31.61

IV. Summary and Conclusions

The ambient and traffic noise levels near Vijayawada are studied. Four locations are selected for ambient noise levels determination and sampling is carried out for two days to check the accuracy of the results. The noise levels are exceeding at commercial and industrial areas while they are within the limits at silent and residential areas. Traffic noise is determined at two locations. Sampling is carried out on two days including non-working days to assess the impact of traffic on working day. A 2dB reduction is observed in the study at each of the locations. Sound attenuation is determined in the lab using different combinations of absorbing materials. A maximum reduction of 36% is noticed for a combination of thermocol + wood + Cloth + Metal on a table. This information will help in assessing a suitable combination of absorbents when designing for noise reduction from point sources.

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