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Evaluation of Noise Levels and Ascertaining Noise Indices in an Urbanizing City of Kota, Rajasthan, India

Bane Singh and Mahendra Pratap Choudhary†
Department of Civil Engineering, Rajasthan Technical University, Kota-324010, Rajasthan, India
†Corresponding author: Mahendra Pratap Choudhary

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L_{np} (Noise pollution level)
TNI (Traffic noise index)

ABSTRACT

Limited studies have been carried out for assessing the holistic scene of noise levels. Monitoring of ambient noise is occasionally conducted in Indian cities, whereas the noise has been fast emerging as a silent killer throughout the urbanized world. We have immense data for air and water pollution, but only limited international figures for the European region are available pertaining to the health impact of environmental noise through a preliminary study carried out by the WHO in 2011. The city of Kota is one of the highly industrialized cities of India, which is still marching ahead on the trajectory of urbanization and decisively breached the one million population figure in 2011 itself. With stupendous growth, it has simultaneously acquired the intrinsic maladies of cities largely witnessed in the developing geographies. One of the several afflictions is excessive noise which warrants a considerate study. Studies have been undertaken to assess the noise levels in the five chosen pockets of the Kota city bearing industrial, residential and commercial characters. Measurements of L_{10}, L_{50}, L_{90} and L_{eq} have been taken and NC, TNI and L_{np} have also been ascertained. An innovative effort of evolving a Noise Quality Index has been endeavoured. The highest NC (noise climate) has been observed in the industrial area, whereas, the lowest in residential cum industrial area. On the other hand, the highest L_{eq} is observed in the industrial area itself, but the lowest is observed in the residential cum commercial area. The overall study suggests that some pockets are affected by the growing nuisance of noise pollution, and the city is gradually hurtling towards high noise ambience.

INTRODUCTION

Noise as a nuisance was known to even the ancient Romans along-with medieval Europe and appropriate rules were in place to thwart noise pollution. With the invention of new construction equipment and e-gadgets the noise has directly reached into our homes or rather ears through earphones of mobiles and iPods. In recent times, noise has become ubiquitous and penetrated our lives heavily. A substantial portion of about 40% of the population in the EU (European Union) countries is exposed to road traffic noise at levels exceeding 55 dB(A), whereas 20% is exposed to levels exceeding 65 dB(A) during the daytime and more than 30% is exposed to levels exceeding 55 dB(A) at night (Jakovljevic et al. 2006). These findings assume serious implications arising out of ambient noise. Mass awareness about health implications emanating out of noise is still abysmally low. Several studies have corroborated and brought out the noise impacts that could be divided distinctly into four 'P's i.e., Physical (hearing impairment and/or loss), Physiological (stomach ulcer, elevated blood pressure, irregular heartbeats), Psychological (disturbance in sleeping pattern, sleeplessness, annoyance, irritation, augmentation in stress) and Performance effects (reduction in work output, marred performance, hearing misunderstanding) (Olayinka 2013). Studies on the effects of chronic exposure to noise on children, have pointed out the impairment of early childhood development and education, and may have lifelong effects on academic achievement and health. Apart from this, consistent exposure harms the cognitive performance in children, consistent association with impaired well-being and motivation to a slightly more limited extent and moderate evidence of effects on blood pressure and catecholamine hormone secretion (Berglund et al. 2009). Thus, put together, the noise pollution is extremely pernicious and impacts perfidiously, therefore, warrants study in its entirety.

Kota is a city bearing the distinct flavours of industrialization and hectic commercial activities. The city is located in the south-eastern part of the State of Rajasthan, identified on the map by 75°52' E longitudes and 25°10' N latitudes. It is a well known regional urban centre abuzz with academic and industrial activities. The city is well positioned to tap into the opportunities presented by the DMIC (Delhi Mumbai Industrial Corridor) and EWC (East-West Corridor). It has numerous industries in and around 25 large/medium industries, 9131 micro/small enterprises with AU (Artisan Units). The city is marked by heavy density of popu-

lation (19/ha) and tremendous vehicle fleet of around 6.5 lakhs. These parameters considerably augment the noise generating potential of the city.

STUDY AREA

Five representative stations of the Kota city have been chosen, representing industrial, commercial, residential cum commercial and purely residential. The brief of the selected areas is as under:

Station Code	Name of Area	Type of Area
A	Bhamashah Mandi Road	Industrial Area
B	Anantpura, MBS Road	Residential
C	Vigyan Nagar	Residential cum Commercial
D	CAD Circle	Commercial
E	DCM Circle	Industrial cum Residential

The station "A" represents Bhamashah Mandi Road (industrial area), Station "B" represents MBS Road originating near Reliance Petrol Pump Anantpura (residential), Station "C" Vigyan Nagar (residential cum commercial), Station "D" CAD Circle (commercial) and the station "E" DCM Circle (industrial cum residential). Station "A" falls in the industrial area and heavily loaded trucks frequent the road for the transportation of grains to the nearby Bhamashah Mandi and other industrial crude and finished products. Station "B" lies on the road leading to newly developed residential apartments in multistorey towers and recently developed colonies, thus it is purely a residential area. Station "C" is a mix of residential area which has hectic commercial activities in the form of numerous shops, vendors, educational institutions, etc. CAD Circle represents station "D" where offices of CAD, Nagar Nigam, UIT and Income Tax are functional along with commercial shops. It thus constitutes a purely commercial area. Station "E" is at the crossroad beside which gigantic DCM factory is located and on the opposite side residential quarters have sprung up profusely making it industrial cum residential area. Thus, this judicious selection of 5 stations adequately represents the various mixes of the area.

METHODS AND MATERIALS

Both subjective and objective assessments of noise levels have been carried out for the city that spilled over from February 2016 to September 2016. Subjective assessment has been conducted through the field survey involving respondents which were drawn both from old and new city and asking their opinions. Objective assessment has been carried out with the help of quest precision integrating/logging sound level meter (Fig. 1), following the due calibrations.

Fig. 1: Sound level meter.

Observation of the parameters such as L_{10}, L_{90} and L_{50} in addition to L_{eq} was carried out at the five designated locations mentioned above. This imparts a holistic picture of Noise Climate (NC), Noise Pollution Level (L_{np}) and Equivalent Continuous Noise level (L_{eq}). The observed values and deduced values of NC, L_{np} and TNI (Traffic Noise Index) are depicted in Table 1. Since the observed values are in decibels hence cannot be averaged out, therefore, critical parameters have been worked out separately for the each station. The following formulae have been deployed to work out NC, L_{np} and TNI as found in the literature (Bande & Nawathe 2013, Tripathi et al. 2006, Hunashal & Patil 2012).

$$NC \text{ (Noise Climate)} = L_{10} - L_{90}$$

$$L_{np} \text{ (Noise Pollution Level)} = L_{50} + [NC^2/56] + NC$$

$$TNI \text{ (Traffic Noise Index)} = L_{90} + 4\,[L_{10} - L_{90}] - 30$$

RESULTS AND DISCUSSION

The summary of results obtained through measurement of various noise parameters is given in Table 1 as well as Fig. 2. The permissible limits of environmental noise as per the Central Pollution Control Board of India are given in Table 2.

The observations for the station "A" which is situated in an industrial zone, the L_{eq} 74.3 dB(A) is just marginally below the day time noise standards of 75 dBA. L_{eq} for the station "B" has been observed as 61 which is well above the day time noise standard of 55 dB(A) for residential area. Station "C" falls below the standard limit of 65 dB(A) for commercial area, whereas, station "D" exceeds the prescribed limit of 65 dB(A). Station "E" also represents industrial area, therefore, L_{eq} levels of 63.7 dB(A) can be accepted as they

Table 1: Observed noise parameters and deducted noise indices.

Station	Observed Noise Parameters in dB(A)				Deducted Noise Indices		
	L_{10}	L_{50}	L_{90}	L_{eq}	NC	L_{np}	TNI
A	77.9	65.0	57.0	74.3	20.9	93.7	110.6
B	60.9	56.0	49.8	61.0	11.1	69.3	64.2
C	52.0	46.7	36.0	52.0	16.0	67.3	70.0
D	74.7	70.4	64.5	71.1	10.2	82.5	75.3
E	64.8	62.0	59.7	63.7	5.1	67.6	50.1

Table 2: Environmental noise standards prescribed by Central Pollution Control Board, India, 2000.

S. No.	Type of Area	Environmental Noise Standards (L_{eq}) in dB (A)	
		Day time	Night time
1	Industrial	75	65
2	Commercial	65	55
3	Residential	55	45
4	Silence	50	40

are below 75 dB(A).

TNI has been devised and evolved in the United Kingdom which measures the annoyance responses to vehicular traffic. A level of 74 dB(A) is found in various social surveys to cause less than 3% dissatisfaction, and hence considered as a threshold limit (Langdon & Scholes 1968).

Station "A" along with "D" shows violation of accepted TNI of 74 dB(A). This is due to the fact that these two stations are marked by heavy traffic movement, the former being situated in the new grain Mandi area where heavily loaded trucks pass on too frequently and the latter being located in the area where both heavy traffic volume as well as intense commercial activities are present. Stations "B", "C" and "E" fall below the acceptable TNI. From the L_{np} (Noise Pollution Level) point of view, only the station "A" breaches the maximum prescribed outdoor value of 88 dB(A), whereas, other stations remain within the permissible limit.

NC (Noise Climate) represents the range over which the sound levels fluctuate in the given time interval. Station "A" represents the highest fluctuation with the NC levels of 20.9. The station "E" has registered the lowest fluctuation owing to relative stability of noise sources. Though L_{10} (peak level), L_{50}, L_{90} (ambient level), L_{eq} (equivalent continuous noise level), L_{np}, NC and TNI all put together help understand comprehensively the noise scene prevailing in the various pockets of the city, yet it is difficult to assign a single quality value from these indices and the analogy. We have endeavoured to impart some value in the form of quality rank from which even a layman can infer some conclusions. We have, therefore, further taken cues from the works of

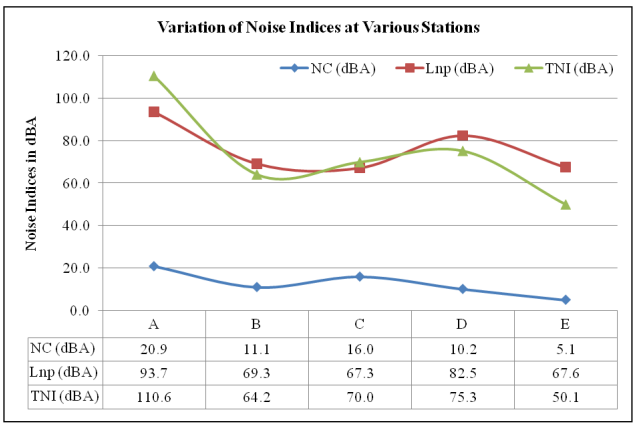

Fig. 2: Variation of noise indices at various stations in Kota city.

Moura-de-Sousa & Cardoso 2002 and WHO guidelines (2009). The assignment of quality ranks has been done as given in Table 3.

From the observed values of L_{eq}, the quality ranks have been worked out for the each station and averaged out for the entire city which is evident from the Table 4.

The subjective analysis was also carried out involving 136 respondents drawn from old and new Kota. Each respondent was asked to give a ranking of noise quality scene of their city on a scale graduated 1-5 with 1 indicating very poor and 2 poor, 3 fair , 4 good and 5 very good or excellent. The average score of this subjective assessment came out as 3.17. We further assigned weights of 0.75 to the objective assessment and 0.25 to the subjective assessment. Thus, the overall score comes out as 2.89 which could be placed somewhere between poor to fair.

CONCLUSIONS

It is amply evident from the observations and results that some pockets of the city are badly affected by the growing menace of noise pollution. Industrial areas are marked by the highly fluctuating noise (Noise Climate) accompanied by the high level of L_{eq}, though marginally safe. Noise levels of 61dB(A) in residential area evoke concern as it exceeds the permissible limit of 55 dB(A). People residing in the residential areas suffer from the elevated noise levels, particularly where construction activities are in full swing, without adequate prevention measures. Presence of numerous vehicles, heightened industrial and commercial activities have significantly contributed towards heightened L_{eq} and TNI.

SUGGESTIONS

- Much responsibility lies on the part of builders, who are undertaking multistorey construction in the various pockets of the city, to sensibly undertake statutory pre-

Table 3: Ranges of $L_{eq,}$ description and quality rank.

Values of L_{eq}	<50	50-55	56-65	66-80	>80
Description	Annoying but can be adapted	Light stress and discomfort	Deep stress	Release of biological morphine causing dependence	Hearing impairment and irreversible losses
Quality Rank	5	4	3	2	1

Table 4: L_{eq} and quality rank of the objective assessment at various stations.

Station	A	B	C	D	E
L_{eq} level	74.3	61.0	52.0	71.1	63.7
Quality rank	2	3	4	2	3
Average of all Stations			2.8		

vention measures. The Noise Pollution (Regulation and Control) Amendment Rules 2010 of India have brought the entire construction activity under its ambit. They need to be adhered to.

- Noise barriers need to be installed at select locations so as to safeguard residential pockets from the noise flow emanating from the adjoining busy streets.
- There is also dire need of reduction of vehicles' fleet on the road, for which vehicle sharing, maximising use of public transport and odd-even protocol are effective deterrents. The overall situation though can not be termed highly dangerous as of now, but warrants concern as some pockets have shown levels of about 75 dB(A) and the same causes dissatisfaction to some extent and if this exceeds 85 dB(A) then the situation might turn worse. It becomes imperative for such an area to resort to traffic segregation.
- All vehicles carrying load greater than 5 tonnes could well be allowed to enter beyond 10.00 p.m., this would alleviate the noise pressure felt in the area.
- Honking needs to be banned while negotiating through the residential areas. The area registering 75 dB(A) is starkly devoid of tree lines hence a thick tree line should be placed on both side of the streets to absorb the excessive noise.
- People dwelling in the areas prone to elevated noise levels should make use of noise dosimeter to monitor the noise levels and exposure times so as to calculate noise dose, one is getting every day.

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