Assessment of noise level due to vehicular traffic at Warangal city, India

Article *in* International Journal of Environment and Pollution · January 2007

DOI: 10.1504/IJEP.2007.014508

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Abstract: In the light of the rapid growth of vehicles and the ill effects due to noise pollution, there is a need to study noise pollution from the transportation point of view. In this study, an attempt has been made to study noise pollution due to vehicular traffic in Warangal city, India. It was observed that noise levels are increasing with increased traffic volume. Studies also revealed that 3-wheelers have a major influence on noise levels. It was found that the noise levels at all the locations studied exceeded the Indian standard ambient noise levels.

Keywords: noise level; traffic; highway; pollution and correlation.

Reference to this paper should be made as follows: Sharma, P.S., Raju, S.S.S.V.G., Murali, M. and Prasad, C.S.R.K. (xxxx) 'Assessment of noise level due to vehicular traffic at Warangal city, India', *Int. J. Environment and Pollution*, Vol. x, No. x, pp.xxx–xxx.

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1 Introduction

Growing urban centres necessitate a sprawling transportation network, increasing the distance between places of residence and work, which needs to be covered in minimum time. The increased socio-economic status of the urban population, coupled with the inadequacy of public transport has encouraged personalised means of transport. With the increasing incidence of health impacts from air and noise pollution, there is a need to study the urban transport-environment interaction and its consequences, in order to plan and manage air and noise pollution problems in urban areas. Tables 1 and 2 present the permissible limits for noise pollution in India. The research work presented in this paper is an effort to investigate the highway noise pollution by conducting traffic and noise level studies at selected locations along the major roads of the city transport network in order to understand the noise level scenario and suggest mitigation measures.

Table 1 Ambient noise standards (India)

	L_{eq} dBA	
Area	*6 a.m.–9 p.m.*	*9 a.m.–6 p.m.*
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silence zone	50	40

Source: IRC: 104 (1988)

Table 2 Noise level standards for residential areas in India

Location	*Acceptable noise level in dBA*
Rural	25–35
Suburban	30–40
Residential	35–45
Urban (residential and business)	40–45
City	45–50
Industrial Areas	50–60

Source: IRC: 104 (1988)

2 Literature review

Literature on noise pollution in India mostly covers the noise level assessment and its apportionment. In line with the zonal classification, the noise pollution assessment efforts are also divided into residential, industrial and sensitive zones. The classification could also be based on the source of pollution, viz. construction, industrial activity and transportation activities. Following are few such efforts towards noise pollution assessment and apportionment in Indian cities.

Sarin (1970) evaluated the road traffic noise problems of residential scientists' apartments near a very busy and important highway intersection in Delhi. It was found that the equivalent noise level was very high at all the floors (up to the 7th floor) compared to the permissible noise level by Indian Standards (Sarin, 1970). Reddy and Bhaskar (1993) studied traffic related environmental factors, such as noise and air pollution, at some selected locations in Delhi Metropolitan city, India. At about 12 busy intersections on NH-2, the noise level and traffic volume were recorded. It was found that even the minimum noise level recorded is higher than the maximum allowable limit of noise pollution (Reddy and Bhaskar, 1993). Dharwadkar et al. (1999) studied noise levels in Aurangabad city, India and found that the transport system, the public address system and entertainment gadgets mainly contribute to the noise (Dharwadkar et al., 1999). Dhembare et al. (1999) assessed the noise on the basis of traffic and vehicular activity at various sites in Nasik city and compared the results with standard noise levels (Dhembare et al., 1999).

In an effort to assess the impact of construction activities on noise pollution, Jain (1991) had studied the construction activities on existing Indian highway SH-45 (now NH-58) by taking observations of volume, speed, noise level and suspended particulate matter. Four stations were selected with two on construction sites, and the others away from the construction sites. Jain (1991) had reported that the noise levels were considerably high at the construction sites.

Monica and Shrivastava (1999) investigated the noise levels prevailing in commercial areas of Jabalpur city and concluded that the high noise levels are associated with higher population density, increased human activities and high density of traffic and lack of greenery (Monica and Shrivastava, 1999). Subrata and Sridharan (1999) assessed noise levels in the Neyveli region of India and found that industrial activity and vehicular movement are the two major sources of noise in the region. Various mitigation measures have been suggested to keep the noise level within the prescribed standards (Subrata and Sridharan, 1999).

Das et al. (1999) monitored the environmental noise at industrial, residential and commercial sites in Jaipur and found that noise levels exceeded the allowed values at all commercial and residential areas, except for one location in the residential category (Das et al., 1999). Ravichandran et al. (2000) assessed noise pollution in Pudukkottai, Tamil Nadu. The ambient noise levels were measured at selected places representing the silence zone, the residential zone and the commercial zone, to assess the extent of noise pollution and concluded that the vehicular traffic with air horns are the main reason for these high noise levels (Ravichandran et al., 2000).

Severe noise pollution affects the health, particularly for the aged population. In an effort to understand such impacts Monica and Shrivastava (2000) analysed the health effects of noise pollution in commercial areas with the help of a questionnaire survey. The study revealed that the persons in commercial areas face different types of health problems and persons above 40 years of age were greatly affected due to noise pollution (Monica and Shrivastava, 2000). The present study is an effort to comprehensively test noise pollution levels at different locations, covering all zones of a city with its major road cutting across the city boundary.

3 Methodology

This study is mainly intended to measure the noise levels in urban and semi-urban locations and hence the locations were so chosen as to represent the different zones within an urban area like, residential zone, commercial zone, silence zone and heavy traffic zone. For the present study data were collected from eight sites (Figure 1) in Warangal city, India. Following are the details of the sampling sites

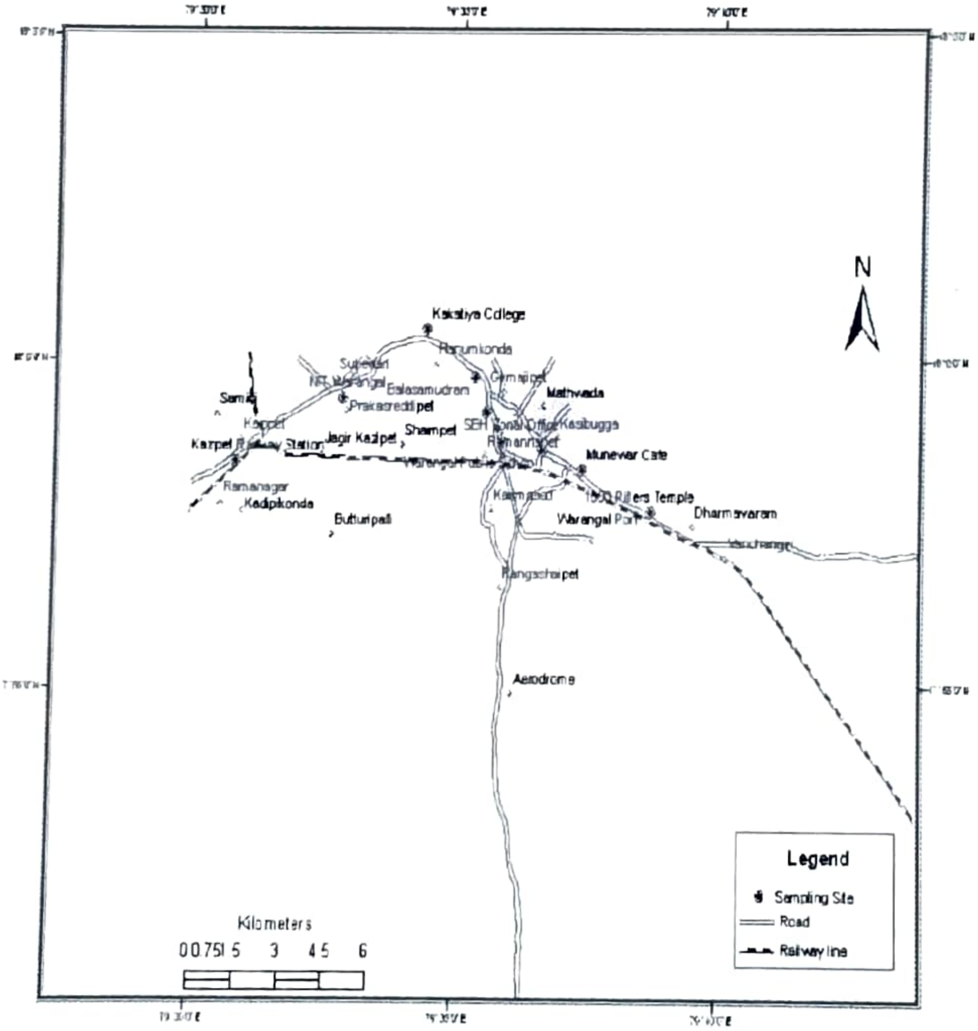
- 1000 pillars temple
- Kazipet railway station
- Balasamudram
- S.B.H zonal office
- Warangal public school
- Kakatiya college
- Munawar café
- National Institute of Technology, Warangal.

The basic noise data was obtained using a noise level meter placed 1.2 m above the ground. Vehicles were divided into six categories, namely, cars, two wheelers, buses, trucks, three wheelers and bicycles. A field data collection programme was chalked out to collect data regarding parameters such as classified traffic volume; ambient noise level; carriageway width, and distance from the roadway. The energy mean noise level of a specified period (L_{eq}) and the sound pressure level in dB (A) exceeded for 10% of the time (L_{10}) were calculated using the collected data. Calculations are performed for all possible correlation coefficient (r) between the parameters by using the following equation.

$$r = \frac{\Sigma X - \overline{X} \times Y - \overline{Y}}{\sqrt{\Sigma(X - \overline{X})^2 \times \Sigma(Y - \overline{Y})^2}} \qquad (1)$$

with 'r' ranging from −1 to +1. More accuracy of fitness is expressed by more closeness of r values to unity. No definite relationship is attributed to r at zero while the negative sign would mean that Y decreases with increasing X.

Figure 1 Sampling sites in study area, Warangal, Andhra Pradesh, India



4 Results and discussions

The traffic volume and noise level studies at all eight locations are discussed below.

- *1000 pillars temple (residential/sensitive zone).* Since this is an ancient monument, the traffic at this junction is more in the evenings and also on holidays. The majority of traffic comprises three wheelers, two wheelers, cars and buses. There are no commercial trucks observed at this junction. The noise levels in this place reveal that they are beyond permissible limits. The results obtained from traffic volume studies and noise level studies at this location are presented in Table 3.
- *Kazipet railway station (commercial zone).* In this place the major portion of the traffic includes buses, cars, three wheelers and also trucks. The noise levels in this place signify that they have exceeded the permissible limit. The results obtained from traffic volume studies and noise level studies at this location are presented in Table 4.
- *Balasamudram (residential zone).* Three wheelers and two wheelers contributed to most of the noise at this place and the noise levels observed are also higher than the permissible limits. The observations were made in peak hours. The results obtained from traffic volume studies and noise level studies at this location are presented in Table 5.
- *S.B.H Zonal office (residential/commercial zone).* There is no commercial traffic observed at this place. The average noise level recorded between 4.00 p.m. to 7.00 p.m. is 76.06 dB. Three wheelers are the major cause of noise. The results obtained from traffic volume studies and noise level studies at this location are presented in Table 6.
- *Warangal public school (residential/sensitive zone).* Though the truck traffic is more when compared to other locations, the average noise levels observed between 10.00 a.m. to 12.30 p.m. are 68.84 dB. Noise levels at this place cross permissible limits. The results obtained from traffic volume studies and noise level studies at this location are presented in Table 7.
- *Kakatiya college (residential/sensitive zone).* High volume of traffic is observed at this place including truck and bus traffic. The percentage of three wheelers is more in the composition when compared to other locations. The observations are made between 9.15 a.m. to and 12.15 p.m. and accounts for an average noise level of more than 76 dB. The results obtained from traffic volume studies and noise level studies at this location are presented in Table 8.
- *Munawar café (residential zone).* The traffic observations were made between 9.45 a.m. from 12.45 p.m. The average noise level observed is 74.97 dB which is beyond the permissible limit. The results obtained from traffic volume studies and noise level studies at this location are presented in Table 9.
- *NationalInstitute of Technology, Warangal (sensitive zone).* The average noise level this area was observed to be 74.3 dB. Since this is a major educational institute in the state, the contribution of two wheelers, three wheelers and cars to noise is more when compared to other vehicles. The results obtained from traffic volume studies and noise level studies at this location are presented in Table 10.

Table 3 Traffic volumes and noise levels at 1000 pillars temple

Time (p.m.)		*Buses*	*3-Wheelers*	*Trucks*	*Cars*	*2-Wheelers*	*Bicycles*	*Total volume*	*Carriage way width* (m)	*Distance* (m)	L_{eq}	L_{10}
From	*To*											
3:30	3:45	9	215	0	25	130	36	415	10.50	10.00	75.5	75.7
3:45	4:00	9	196	0	33	168	41	447	10.50	10.00	76.5	77.9
4:00	4:15	6	205	1	18	164	63	457	10.50	10.00	73.6	75.2
4:15	4:30	15	215	0	21	179	45	475	10.50	10.00	74.6	75.7
4:30	4:45	8	242	0	28	156	51	485	10.50	10.00	74.0	75.7
4:45	5:00	10	251	0	40	156	58	515	10.50	10.00	80.3	83.3
5:00	5:15	8	234	0	32	192	58	524	10.50	10.00	74.9	75.4
5:15	5:30	7	245	0	27	194	71	544	10.50	10.00	74.5	76.4
5:30	5:45	10	233	0	20	185	59	507	10.50	10.00	73.7	85.7
5:45	6:00	5	236	0	23	173	74	511	10.50	10.00	74.2	76.0
6:00	6:15	11	242	0	32	192	46	523	10.50	10.00	75.1	76.3
6:15	6:30	10	208	0	45	200	107	570	10.50	10.00	82.3	87.7
6:30	6:45	7	223	0	24	213	83	550	10.50	10.00	74.1	75.3
6:45	7:00	7	232	0	28	189	92	548	10.50	10.00	76.0	78.6

Table 4 Traffic volumes and noise levels at Kazipet railway station

Time (p.m.)		Buses	3-Wheelers	Trucks	Cars	2-Wheelers	Bicycles	Total volume	Carriage way width (m)	Distance (m)	L_{eq}	L_{10}
From	To											
4:00	4:15	12	223	8	39	137	104	523	15.40	3.20	70.7	73.7
4:15	4:30	12	214	14	32	140	60	472	15.40	3.20	71.9	74.7
4:30	4:45	16	254	17	46	154	69	556	15.40	3.20	74.3	75.8
4:45	5:00	15	281	20	44	135	107	602	15.40	3.20	73.8	76.1
5:00	5:15	10	336	6	44	155	118	669	15.40	3.20	72.4	74.5
5:15	5:30	15	335	8	60	163	120	701	15.40	3.20	74.0	75.6
5:30	5:45	17	256	10	25	145	106	559	15.40	3.20	73.0	74.6
5:45	6:00	17	263	13	35	155	102	585	15.40	3.20	74.4	76.9
6:00	6:15	8	195	9	30	85	100	427	15.40	3.20	76.4	76.7
6:15	6:30	10	204	11	18	142	99	484	15.40	3.20	76.2	74.8
6:30	6:45	16	194	23	44	183	156	616	15.40	3.20	71.4	74.3
6:45	7:00	14	200	8	34	103	97	456	15.40	3.20	74.0	74.2

Table 5 Traffic volumes and Noise levels at Balasamudram

Time (p.m.)									*Carriage way*	*Distance*		
From	*To*	*Buses*	*3-Wheelers*	*Trucks*	*Cars*	*2-Wheelers*	*Bicycles*	*Total volume*	*width* (m)	(m)	L_{eq}	L_{10}
4:00	4:15	4	85	2	29	128	22	270	10.20	10.00	69.1	71.3
4:15	4:30	5	97	0	19	170	35	326	10.20	10.00	70.2	71.1
4:30	4:45	7	127	1	36	166	52	389	10.20	10.00	69.5	72.0
4:45	5:00	9	88	0	35	187	32	351	10.20	10.00	69.1	72.2
5:00	5:15	6	106	0	22	177	28	339	10.20	10.00	70.8	72.3
5:15	5:30	7	112	5	29	208	29	390	10.20	10.00	70.2	72.2
5:30	5:45	2	100	0	27	225	17	371	10.20	10.00	69.1	70.9
5:45	6:00	4	96	4	40	242	27	413	10.20	10.00	69.9	72.2
6:00	6:15	5	106	1	39	208	17	376	10.20	10.00	70.5	73.0
6:15	6:30	4	109	1	24	212	41	391	10.20	10.00	69.6	72.1
6:30	6:45	3	86	1	27	203	47	367	10.20	10.00	70.9	73.6
6:45	7:00	3	91	2	18	229	63	406	10.20	10.00	70.0	72.4
7:00	7:15	7	85	0	40	264	55	451	10.20	10.00	70.1	71.7
7:15	7:30	3	95	1	34	226	63	422	10.20	10.00	69.2	71.6

Table 6 Traffic volumes and noise levels at S.B.H zonal office

Time (p.m.)		*Buses*	*3-Wheelers*	*Trucks*	*Cars*	*2-Wheelers*	*Bicycles*	*Total volume*	*Carriage way width (m)*	*Distance (m)*	L_{eq}	L_{10}
From	*To*											
4:00	4:15	3	210	0	21	281	170	685	9.60	4.90	74.9	75.9
4:15	4:30	6	224	0	25	331	160	746	9.60	4.90	75.3	76.8
4:30	4:45	5	242	0	35	383	103	768	9.60	4.90	76.3	77.7
4:45	5:00	3	278	0	35	304	98	718	9.60	4.90	75.8	77.1
5:00	5:15	3	293	0	30	256	103	685	9.60	4.90	74.7	76.2
5:15	5:30	4	209	0	42	413	62	730	9.60	4.90	76.5	78.8
5:30	5:45	4	224	0	23	238	70	559	9.60	4.90	77.5	79.8
5:45	6:00	1	200	0	14	250	60	525	9.60	4.90	76.3	78.3
6:00	6:15	4	328	0	27	363	114	836	9.60	4.90	75.8	77.3
6:15	6:30	1	206	0	25	229	80	541	9.60	4.90	77.0	79.4
6:30	6:45	3	226	0	45	335	109	718	9.60	4.90	75.4	76.7
6:45	7:00	3	203	0	43	326	70	645	9.60	4.90	77.2	78.5

Table 7 Traffic volumes and noise levels at Warangal public school

Time (a.m.)												
From	*To*	*Buses*	*3-Wheelers*	*Trucks*	*Cars*	*2-Wheelers*	*Bicycles*	*Total volume*	*Carriage way width* (m)	*Distance* (m)	L_{eq}	L_{10}
10:00	10:15	0	36	7	17	143	52	255	10.20	10.00	66.9	69.9
10:15	10:30	1	47	10	18	141	29	246	10.20	10.00	68.9	71.9
10:30	10:45	0	26	13	18	148	32	237	10.20	10.00	69.3	72.2
10:45	11:00	2	37	17	34	151	23	264	10.20	10.00	71.1	72.7
11:00	11:15	1	32	13	33	169	38	286	10.20	10.00	69.5	72.7
11:15	11:30	2	40	6	21	91	28	188	10.20	10.00	68.4	70.5
11:30	11:45	3	30	5	23	110	22	193	10.20	10.00	67.2	70.1
11:45	12:00	1	42	16	32	108	24	223	10.20	10.00	69.9	72.2
12:00	12:15	1	26	22	19	122	18	208	10.20	10.00	68.7	71.6
12:15	12:30	1	43	16	24	111	18	213	10.20	10.00	70.2	71.6
12:30	12:45	0	32	12	29	119	16	208	10.20	10.00	67.1	70.1

Table 8 Traffic volumes and noise levels at Kakatiya college

Time (a.m.)		Buses	3-Wheelers	Trucks	Cars	2-Wheelers	Bicycles	Total volume	Carriage way width (m)	Distance (m)	L_{eq}	L_{10}
From	To											
9:15	9:30	14	362	8	48	350	197	979	19.80	3.80	76.6	77.5
9:30	9:45	15	353	7	46	317	177	915	19.80	3.80	75.1	77.6
9:45	10:00	7	405	10	44	417	212	1095	19.80	3.80	76.1	77.9
10:00	10:15	19	393	6	35	357	162	972	19.80	3.80	76.6	78.1
10:15	10:30	12	403	8	51	406	181	1061	19.80	3.80	75.2	77.8
10:30	10:45	14	430	8	68	493	201	1214	19.80	3.80	76.6	77.8
10:45	11:00	18	405	8	44	356	107	938	19.80	3.80	76.4	78.8
11:00	11:15	14	456	9	65	502	146	1192	19.80	3.80	76.7	78.5
11:15	11:30	17	392	9	60	401	126	1005	19.80	3.80	77.3	77.9
11:30	11:45	8	434	9	73	487	137	1148	19.80	3.80	75.6	77.7
11:45	12:00	13	395	18	88	558	134	1206	19.80	3.80	76.6	78.2
12:00	12:15	6	435	5	67	423	113	1049	19.80	3.80	79.3	78.8

Table 9 Traffic volumes and noise levels at Munawar café

Time (a.m.)		*Buses*	*3-Wheelers*	*Trucks*	*Cars*	*2-Wheelers*	*Bicycles*	*Total volume*	*Carriage way width* (m)	*Distance* (m)	L_{eq}	L_{10}
From	*To*											
9:45	10:00	11	244	11	49	318	67	700	18.25	5.50	76.4	77.8
10:00	10:15	12	282	21	53	422	89	879	18.25	5.50	74.6	77.3
10:15	10:30	14	271	20	62	309	33	709	18.25	5.50	75.1	78.0
10:30	10:45	10	226	11	41	322	29	639	18.25	5.50	74.5	77.0
10:45	11:00	14	199	14	76	441	46	790	18.25	5.50	74.5	76.7
11:00	11:15	8	207	26	59	338	42	680	18.25	5.50	74.9	77.3
11:15	11:30	16	176	17	61	304	27	601	18.25	5.50	75	76.9
11:45	12:00	14	225	9	41	260	27	576	18.25	5.50	74.8	76.7
12:00	12:15	13	158	11	60	267	15	524	18.25	5.50	74.9	76.5
12:15	12:30	12	170	13	48	262	22	527	18.25	5.50	74.8	76.9
12:30	12:45	19	184	23	44	305	18	593	18.25	5.50	75.2	77.8

Table 10 Traffic volumes and noise levels at National Institute of Technology, Warangal

Time (a.m.)		Buses	3-Wheelers	Trucks	Cars	2-Wheelers	Bicycles	Total volume	Carriage way width (m)	Distance (m)	L_{eq}	L_{10}
From	To											
10:45	11:00	12	113	0	45	240	41	451	14.75	8.20	73.6	76.6
11:00	11:15	8	137	0	28	229	36	439	14.75	8.20	72.1	74.9
11:15	11:30	9	141	22	36	261	36	506	14.75	8.20	73.6	75.7
11:30	11:45	3	127	0	34	286	22	471	14.75	8.20	71.5	74.6
11:45	12:00	5	119	14	50	301	34	522	14.75	8.20	74.0	77.7
12:00	12:15	6	134	4	49	263	22	478	14.75	8.20	73.3	76.1
12:15	12:30	5	137	5	30	266	51	495	14.75	8.20	74.7	78.6
12:30	12:45	4	109	5	34	258	60	470	14.75	8.20	75.5	78.4
12:45	13:00	4	113	13	22	285	79	517	14.75	8.20	80.4	79.0

Table 11 Correlation matrix for all parameters

	Total traffic volume	*Carriage way width*	*Distance*	*Percentage of bus*	*Percentage of 3-wheelers*	*Percentage of trucks*	*Percentage of cars*	*Percentage of 2-wheelers*	L_{eq}	L_{10}
Total traffic volume	1	–	–	–	–	–	–	–	–	–
Carriage way width	0.66	1	–	–	–	–	–	–	–	–
Distance	0.70	0.63	1	–	–	–	–	–	–	–
Percentage of bus	0.064	0.37	–0.12	1	–	–	–	–	–	–
Percentage of 3-wheelers	0.35	0.37	0.34	0.52	1	–	–	–	–	–
Percentage of trucks	0.40	0.184	0.19	0.078	–0.40	1	–	–	–	–
Percentage of cars	–0.51	–0.11	0.38	0.07	–0.50	0.60	1	–	–	–
Percentage of 2-wheelers	–0.27	–0.43	0.42	–0.52	–0.88	0.17	0.36	1	–	–
L_{eq}	0.63	0.50	–0.44	0.19	0.63	–0.36	–0.48	–0.50	1	–
L_{10}	0.55	0.44	–0.31	0.20	0.58	–0.31	–0.43	–0.44	0.90	1

The correlation matrix for all parameters is presented in Table 11. From the correlation matrix it is observed that the explanatory parameters have less interdependency, except for a few parameters. However, many parameters have reasonable correlation with L_{eq} and L_{10}. Table 11 also reveals that the range of 'r' values for the relation amongst the parameters is of the order of –0.88 to 0.90. A highly positive correlation coefficient is observed in between L_{10} and L_{eq} (0.90), distance and total traffic volume (0.70) while a highly negative correlation coefficient is obtained between the percentage of two-wheelers and the percentage of three-wheelers (–0.88). A positive correlation is obtained between 38 unions (i.e., 2/3 of total number) and the rest of the union shows negative correlation (i.e., 1/3 of the total number). Hence it is concluded that the correlation studies of the parameters has a great significance in the study of traffic noise. It is observed from the field studies that higher traffic volume resulted in higher noise levels. The effect of carriageway width on the noise level is observed to be significant.

5 Conclusions and recommendations

There is a need to study the urban transport environment interaction for better planning and management of the noise pollution problems in urban areas. The study of highway noise is very helpful for engineers to look into the future in a quantitative way, which helps in suggesting mitigation measures. In the present study, an attempt has been made to study highway noise pollution in Warangal city. The study revealed that both traffic and highway parameters influence traffic noise. It was found that two-wheelers and three-wheelers are predominant in the traffic flow. It was also found that noise levels increase with increased traffic volume. A correlation study revealed that three-wheelers influence the noise levels greatly. It is alarming to observe that noise levels are above tolerance levels in sensitive areas such as educational institutes and temples. Higher traffic densities, excessive congestion coupled with the attitudes of drivers and poor infrastructure for non-motorised transport could be a major reason for this severe noise pollution. Though controlling this pollution needs an integrated master plan in long run, the following mitigation measures are recommended in order to control the immediate inconvenience caused due to this excessive noise on roads:

- certain sound absorbing materials (Thermo Cole, coir etc.) should be used in educational institutions located in the vicinity of main roads to reduce the noise level
- trees planted along the roads and also in the vicinity of educational institutions could reduce noise levels, as trees play an efficient role in controlling noise
- organise awareness campaigns for public, and particularly for drivers, explaining noise pollution and related health risks and inconvenience caused to the public, as well as various measures to control the same.

Acknowledgements

The authors express their heart-felt gratitude to the Management and Principal of the College of Engineering, GITAM, Visakhapatnam, India for their encouragement and support. The authors are thankful to Dr. S. Surya Rao, PhD (IOWA), Professor in

Civil Engineering, GITAM, Visakhapatnam (Former Professor, IIT, Kanpur) for his suggestions during the preparation of this paper.

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