Physical Sciences Section

Pak. j. sci. ind. res., vol. 33, no. 5-6, May-June 1990

FREQUENCY AND OTHER PARAMETRIC ANALYSIS OF TRAFFIC NOISE IN KARACHI CITY

G.H. Shaikh and S.S.H. Rizvi

PCSIR Laboratories Complex, Karachi-39, Pakistan

(Received January 30, 1990; revised June 27, 1990)

Octave and 1/3 Octave Band Frequency analysis of traffic noise have been undertaken at some of the major traffic junctions in Karachi city. Also, measurements of noise emission from individual vehicles have been made, readings have been taken for each variety of vehicles playing on city roads, with a view to assessing their individual contributions to the traffic noise. The results have been discussed with reference to speech interference, and possible health hazards due to high noise levels.

Key words: Traffic noise, Surface transportation, Environmental pollution.

Introduction

A study of the traffic noise levels in some selected areas of the busy city centres of Karachi was reported earlier [1]. This study was confined essentially to noise level measurements with a view to assessing their expected impact on community response based on the recommendation for the "Assessment of noise with respect to community response" [2]. While it is true that no vigorous community action against the existing noise situation has come on surface, possibly because of the community's poor awareness about civic privileges, it has, nevertheless, been considered necessary to extend this study further to make an analysis of the traffic noise particularly with respect to speech interference and health hazard, as also the factors contributing to the high noise levels. For this purpose, observational data have been collected on (i) the frequency distribution pattern of the noise, and (ii) the noise emission from individual vehicles of different categories, measurements have been made using standard method [3].

Instruments and measuring techniques. For frequency distribution measurements, the measuring instruments consisted of a Bruel and Kjaer Impulse precision Sound Level Meter, type 2209; a calibrated Condenser Microphone, type 4165; and Octave and 1/3 Octave Band Filter, type 1613 and 1616. The Sound Level Meter was regularly calibrated against a standard source of 123.8 dB at 250 Hz using a B & K Pistaphone, type 4220. The microphone was guarded against wind by a windscreen. All measurements were made at a distance of 7.5m from the edge of the road, keeping the microphone at a height of 1.2m above ground level. The meter was set on "Fast" mode for all measurements.

Octave and 1/3 Octave frequency measurements were made at nine city sites, namely Grumander, Tower, Empress Market, Lasbela, Nursary, Hasan Square, Rashid Minhas Road, Nazimabad Chaurangi and Lea Market. For each site, four sets of 1/3 Octave sound pressure level measurements were made at intervals of 30 minutes; and for each set, ten measurements were taken for each 1/3 Octave band centre frequency over a period of about one minute, and measurements for one set were completed in a period of about 30 minutes. For each octave band sound pressure level in dB, ten measurements were made for each octave band centre frequency over a period of 15 mins: for such sets readings were taken in intervals of 30 mins.

Preferred Speech Interference Levels were calculated in dB by averaging the average octave band sound pressure level centred at frequency 500, 1K and 2K Hz. The Articulation Index (AI) values for these sites were calculated by superimposing each of the 1/3 octave spectra of traffic noise obtained for the different sites (Figs. 2-10) over the curve given for the computation of Articulation Index [4], and counting the number of points between the upper curve of the AI graph and the observed spectrum.

For the measurement of noise emission from the individual vehicles, ISO recommendation R-362 (1964) was followed. Arrangements for the measurements were made on a quiet (almost deserted), hard, and levelled road, having practically no buildings or trees on either side. The same instruments, i.e. Band K Impulse precision Sound Level Meter, type 2209, and Condenser Microphone, type 4165 were used for these measurements. The microphone was set, as recommended, at a distance of 7.5 meter from the line of flow of the vehicle as shown in Fig. 1, and keeping the microphone at a height of 1.2m above ground level. Measurements were made for different varieties of vehicles, viz motor cycles, cars, minibuses, buses, trucks, vans and motor rickshaws. For each veriety, efforts were made to have sample readings for comparatively newer and older models.

The Sound Pressure Level at 1/3 Octave band was recorded for all the different city sites. To get a clearer perspective of the observational data for presentation in graphical form, these were rearranged as follows:

(a) the minimum values of the four recorded sets at each 1/3 Octave band,

(b) the average of the minimum recorded values of the four sets at each 1/3 octave band,.

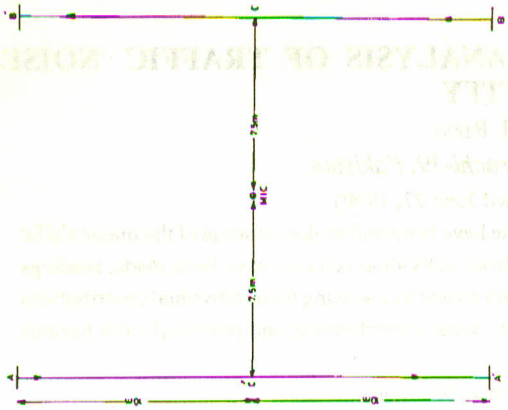

Fig. 1. Schemetic showing the settings for noise level measurements from vehicles in motion.

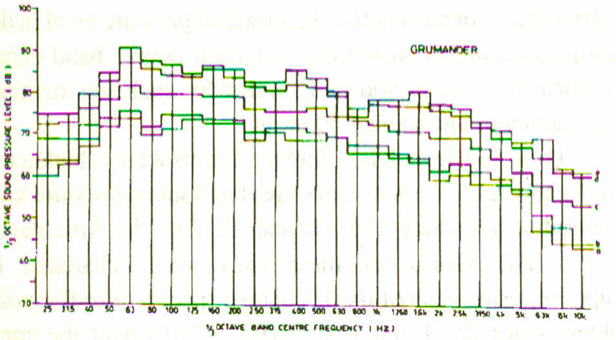

Fig. 2. Grumander

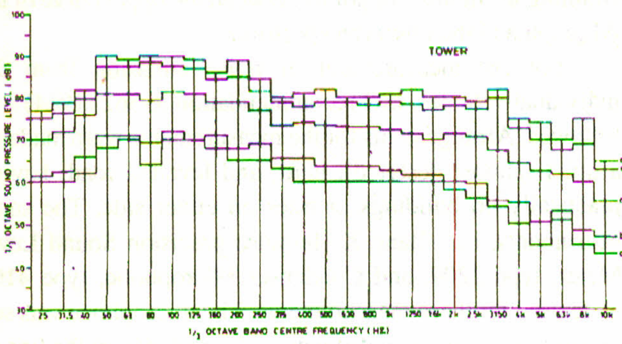

Fig. 3. Tower

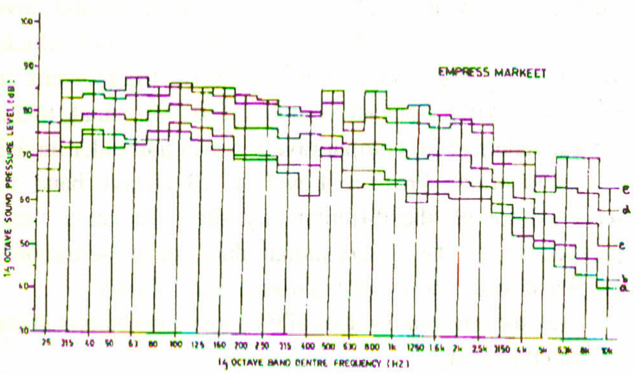

Fig. 4. Empress Market

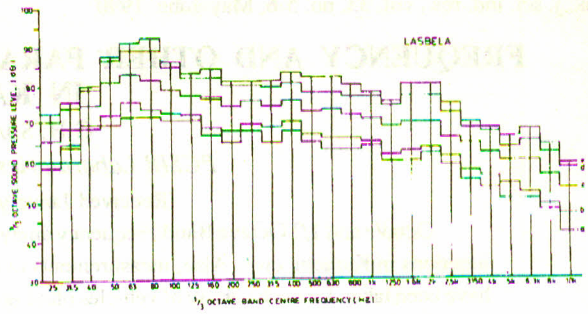

Fig. 5. Lasbela

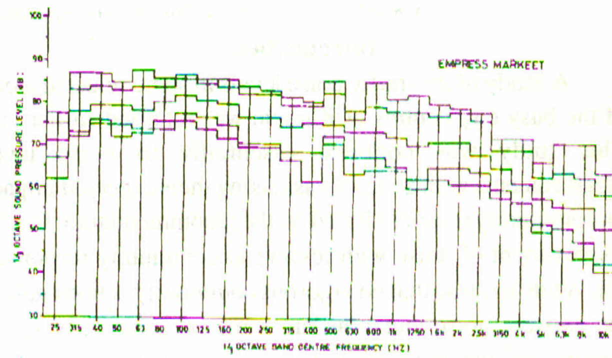

Fig. 6. Nursary

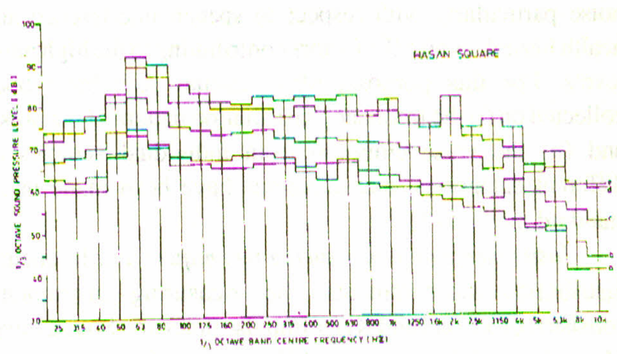

Fig. 7. Hasan square

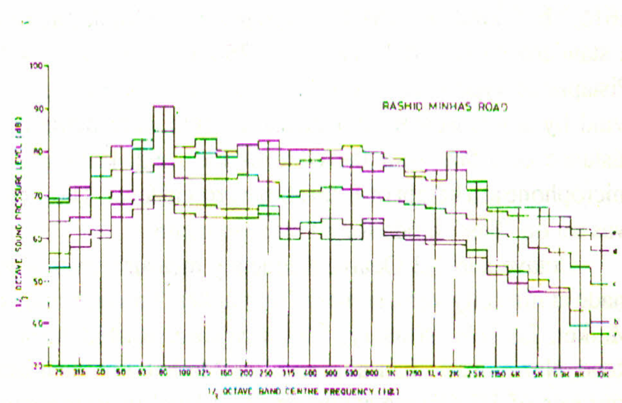

Fig. 8. Rashid Minhas Road

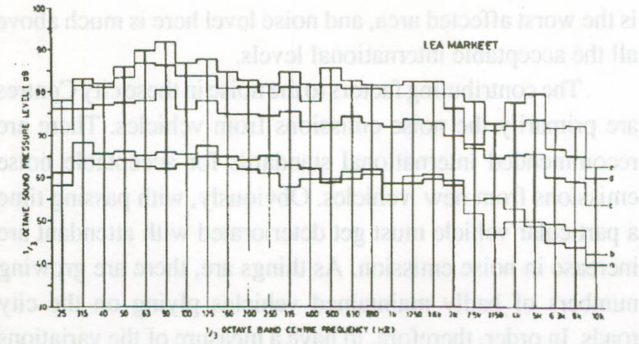

Fig. 9. Nazimabad

(c) the maximum value of the four recorded sets at each 1/3 octave band.

(d) the average of the maximum value at each 1/3 octave band,

(e) the average value of all the recorded values obtained in all the four sets at each 1/3 octave band.

The rearranged data thus obtained have been plotted in Figs. 2-10 for all the nine city sites.

Results and Discussions

One of the immediate ill-effects of high level noise is the speech interference effects: this is particularly important, for in most of these trading centres, many of the shops have no closed doors, as also many others trade in goods displayed on push carts or even on road pavements. For an assessment of the speech interference effects, various methods have been proposed: the simplest are (i) Articulation Index (AI), which requires sound pressure level distribution in the different 1/3 octave bands [5], and (ii) Preferred Speech Interference Level (PSIL), which uses octave band sound pressure level measurements at frequencies centred at 500 Hz, 1KHz, and 2KHz thus covering the frequency range 350 Hz to 2850 Hz [5]. Both the values, AI as well as PSIL, for the different city Centres have been calculated and are given in Table 1. For assessing the level of speech interference between two persons facing each other at a distance of 1.2 meter, Beranek's criteria [5] have been employed. In Table 1 are given the results of this assessment. The results show that at these centres one has to use a very loud to shouting voice to be intelligible. This evidently means that the traders who spend most of their working hours in these areas must get used to talking in loud tones as a matter of habit: this would not only be adversely affecting their vocal chords but also be getting them unconciously rated as socially discourteous.

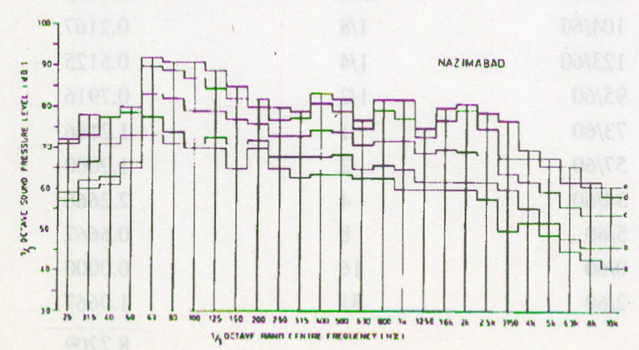

Fig. 10. Lea Market

The ill-effects of noise on health are many; however, not all the ill-effects are quite well studied and definitely established. Albeit, occupational hearing loss has been studied in greater detail particularly with a view to introducing regulatory measures. In this respect, there appears to be some divergence of approach upon which national standards in USA and European countries have been framed; the divergence has been particularly in respect of the allowable exposure duration for a particular level of noise. Using the UK standard [6], 90 dB (A) is the permissible noise level for 8 hrs. per day, working 5 days a week and 48 weeks a year (i.e. 1920 hrs. per year); for that level (i.e. 90 dB (A) of noise exposure), the ISO recommendation [7] allows 40 hrs. working per week and 50 weeks per year (i.e. 2000 hrs per year); Occupational Safety and Health Act of USA [8] allows 8 hrs. continuous exposure per day; Germany, Irish Republic, Italy, Denmark, Canada (Fed.) and Australia also allows 8 hrs. exposure per day [9]. These criteria, however, have been devised for factory situation. And although the road situation is different from a factory situation, yet this criterion may be adopted in this situation as well at least to determine the maximum acceptable noise levels for taking care of the hearing loss hazards for the working people in any working situation where they may have to continuously stay for most of their working period, which in case of market situation in this country extends from roughly 10.00 AM in the morning to about 8.00 P.M. in the evening i.e. 10 hrs per day, 6 days per week and 52 weeks per year (i.e. about 3120 hrs. per year). The total exposure to traffic noise in this situation works out to 3120 hrs. per year. For a comparison of the noise exposure levels in the existing working situation against the allowable international standards, a new parameter, that is, 'noise exposure levels in equivalent hrs. per year', has been used. For the calculation of this parameter, the data given in the earlier paper [1] have been used. The definition of this parameter can be better appreciated by reference to its method of calculation. This is illustrated as follows: the total count of readings for each level of noise are first sorted out, and are arranged in groups of three noise levels. These counts for the different levels in a particular group are then added- up to give the total counts of the readings of the groups. Each group is represented by its centre value. Then the exposure equivalent for this centre dB(A) value is worked out with reference to noise level of 90 dB(A) which is weighted as one. As the loudness level doubles for every increase of about 3 dB(A), the weight for each centre dB(A) value is appropriately determined; for example, noise 87dB(A) is weighted 1/2, while that of 93 dB(A) is weight as 2. The detailed calculation for Empress Market are given in Table 2 as a sample calculation. The data for Empress Market were collected from 10.00AM to 8.00 PM, and 600 observations were made over this period at intervals of 10 minutes.

Table 3 gives a comparison of the International Standards of equivalent noise exposure hours/year (calculated for acceptable limit of 90 dB(A)/year) against Pakistan's working situation of 3120 working hours/year. This table may be used as self-regulating guide for the working people in these place until such time that strict regulatory measures are adopted for controlling noise pollution in these areas. Table 3 shows that Empress Market is the worst affected area, and noise level here is much above all the acceptable international levels.

The contributing factors to the noise in these city Centres are primarily the noise emissions from vehicles. There are recommended international standards for acceptable noise emissions from new vehicles. Obviously, with passing time a particular vehicle must get deteriorated with attendant are increase in noise emission. As things are, there are growing numbers of badly maintained vehicles plying on the city roads. In order, therefore, to have a measure of the variations in the noise emissions from individual vehicles at different stages of their working life, measurements were made on the noise emissions from different varieties of vehicles, namely motor cycles, cars, buses, trucks, rickshaws and mini-buses; efforts were made to collect data for each category of vehicle, both in relatively better as also worse conditions of

Table 1. Calculated PSIL and AI Values at the Nine Survey Sites.

S.No.	Place	Calculated PSIL in dB	Calculated AI values	Level of undesirability of noise: PSIL Criteria	Level of undesirability of noise: AI Criteria
1.	Grumander	75.3	0	Shouting	Unsatisfactory communication
2.	Tower	71.2	0	Very loud	"
3.	Empress Market	74.0	0	Shouting	"
4.	Lasbela	73.7	0	Very loud	"
5.	Nursary	71.0	0	Very loud	"
6.	Hasan Square	73.5	0	Very loud	"
7.	Rashid Minhas Road	73.5	0	Very loud	"
8.	Nazimabad Chowrangi	73.1	0	Very loud	"
9.	Lea Market	74.0	0	Shouting	"

Table 2. Detailed Calculation of Noise Exposure Level in Equivalent Hours Per Year

Group of dB (A) values	Centre dB (A) value for the group	Total counts of readings	Exposu re duration in hours	Weighting factor	Noise level in equivalent hours
71,72,73	72	15	15/60	1/64	0.0039
74,75,76	75	31	31/60	1/32	0.0161
77,78,79	78	61	61/60	1/16	0.0635
80,81,82	81	104	104/60	1/8	0.2167
83,84,85	84	123	123/60	1/4	0.5125
86,87,88	87	95	95/60	1/2	0.7916
89,90,91	90	73	73/60	1	1.2166
92,93,94	93	57	57/60	2	1.9000
95,96,97	96	34	34/60	4	2.2666
98,99,100	99	05	5/60	8	0.6667
101,102,103	102	00	0/60	16	0.0000
104,105,106	105	02	2/60	31	1.0667
Total noise exposure level in equivalent hours per day					8.7209

Total noise exposure level in equivalent hours per year = 8.7209 x 6 x 52 = 2721 hours

TABLE 3. A COMPARISON OF THE INTERNATIONAL STANDARDS OF EQUIVALENT NOISE EXPOSURE IN HOURS/YEAR (CALCULATED FOR ACCEPTABLE LIMIT OF 90 dB (A)/YEAR) AGAINST PAKISTAN'S WORKING SITUATION OF 3120 WORKING HOURS/YEAR

S.No.	Place	Calculated hours	U.K. Standard	ISO Recomm-endation	OHS Act (USA) and other ountries
1.	Grumander	1895	1920 hrs.	2000 hrs.	about 2000 hrs.
2.	Tower	0556			
3.	Empress Market	2721			
4.	Lasbela	1665			
5.	Nursary	1421			
6.	Hasan Square	1002			
7.	Rashid Minhas Rd.	0640			
8.	Naizmabad Chorangi	1100			
9.	Lea Market	1868			

Other countries include Germany, France, Belgium, Irish Republic, Italy, Denmark, Canada (Fed), and Australia.

TABLE 4. LEVELS OF NOISE EMITTED BY DIFFERENT VARIETIES OF VEHICLES.

S. No.	Type of vehicles	Condition of vehicles	Description level	Measured noise level dB(A)
1.	Truck	New	–	–
		Average	Bedford, Model-84	85
		Poor	Bedford, Model-82	90
2.	Car	New	Suzuki (FX-800), Model-87	73
		Average	Datsun (Sunny), Model-83	80
		Poor	Toyota (Corolla), Model-72	83
3.	Bus	New	Bedford, Model -87	79
		Average	Bedford, Model-80	85
		Poor	Bedford, Model-72	89
4.	Motorcycle	New	–	–
		Average	Honda (70-CC), Model-84	84
		Poor	Honda (125-CC), Model-75	88
5.	Minibus	New	–	–
		Average	Mazda, Model-83	85
		Poor	Mazda, Model-78	88
6.	Rickshaw	New	–	–
		Average	Model-81	91
		Poor	Model-76	95
7.	Van	New	Toyota Hiace, Model-87	76
		Average	Toyota Hiace, Model-83	80
		Poor	Toyota Hiace, Model-80	86

This study was conducted in February-March, 1988.

maintenance. The results are given in Table 4. This Table shows that rickshaws are the major contributors to noise polution, followed by trucks and buses. As can be seen, the emission values for the new/properly maintained cars and vans are within the permissible limits [10], but the improperly maintained vehicles indeed give higher noise emmission. Data on a large sample of vehicles would have been desirable, but because of the difficulties in getting hold of people who could volunteer for making their vehicles available for this study, the data so far collected have been used for the analysis of the contribution to noise from these vehicles.

During peak hours, assuming six vehicles running (three in each carriage way of a double-carriage way road) side by side, the combined noise for two theoretical situations has been worked out: (i) for a combination of well maintained motor cycle, car, minibus, rickshaw, bus, truck and (ii) for the combination of the same varieties of vehicles, but all poorly maintained. The results for the two cases worked out to 93 dB(A) and 96 dB(A) respectively. If the contribution due to rickshaws are left out then the corresponding values work out to 88 dB(A) and 91 dB(A). Obviously the contribution from other vehicles, leading and following, must be added. Indeed, these values are indicative of worst situation: the actual average values of noise levels in these centres are certainly lower than these values. Nonetheless, the peak values do occassionally approach these high values particularly at low frequency. In case of Empress Market, Tower, Grumander, and Lea Market the average peak levels persist in the range 76 ± 4, 75.5 ± 4, 75± 4, and 76± 5 dB(A) values over a wide frequency range extending from 178 Hz to 4470 Hz. This certainly speaks of an alarming situation. To conclude, two things can be safely said to emerge out from this study: (i) the emission from rickshaws alone outweights the emissions from other vehicles, and (ii) proper maintenance of vehicles may help to reduce the noise levels, for which proper regulatory laws may be desirable.

Acknowledgement. The authors are indebted to M/s. Dabir Ahmad, Nabi Ahmad Khan, and Abdul Wahab Khan for their assistance and cooperation in the collection of some observational data.

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