inter·noise 83

ANALYSIS OF ENVIRONMENTAL NOISE AND DETERMINATION OF HIGHEST ACCEPTABLE NOISE LEVELS WITH REGARD TO NOISE CONTROL IN ISTANBUL

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INTRODUCTION

In recent years, the field of interest on environmental noise has been widening by numbers of studies in order to assess the noise nuisance, to modify the existing standards, to confirm and simplify the prediction methods and to develope new measurement techniques. As it is known analysis of local noise conditions and responses is fundemantally important in setting of discomfort criteria, since adaptation standards can not be apparently considered as impact-indicators of different communities. Therefore, this research supported by Scientific and Research Council of Turkey, has been started to ensure several objectives, on the one hand to measure the noise levels from road, rail and aircraft traffic at sampling sites of Istanbul city, on the other hand to carry out a social survey regarding to traffic noise solely due to its majority in the city. By relating the results, it has been attempted to predict the annoyance from noise and to set acceptable limits from standpoint of urban noise control with the aid of the some procedures widely used.
As a third purpose, some field and laboratory measurements were made to investigate the actual facade insulation which is directly concerned with the annoyance at sampling sites.

NOISE MEASUREMENT AND ANALYSIS

Outdoor noise measurements were carried out at 17 sites where the noise levels are relatively high and the housing blocks have been oriented towards the source with their greater facades. The traffic noise was analysed in some streets without intersections and some parts of a highway closely passing through the built-up areas, where the traffic volume and the percentage of heavy vehicles were respectively over 1000 vehicle/hour and 10%. During the measurements, the traffic was free-flowing at each site. The areas which the railroad noise was measured, were selected from close and semi-close areas according to the railway

and site configuration. For air-craft noise on which further studies are essential, the samples were taken from two groups of sites surrounding the International Yeşilköy Airport, one just under the take-off path and the others located as parallel to the main runway.
The technique and B&K equipment mentioned in ISO/R/1996 and 2204 were used for measurements which were made between 7.00-19.00 hours by taking samples in every 10 minute per hour for traffic noise. The variations of noise levels during the weekdays (Monday, Wednesday and Friday) were computed. Different types of trains and aircrafts were recorded at reference points. All the data related to the source operations (like traffic volumes, speeds, daily flights etc.) were acquired to be able to identify the noise conditions in terms of simple and some complex noise units. Besides, the frequency spectrums were analysed for single noise events.

Social Survey

The purpose of the questionnaire was to determine; a) The general complaints of the environment, b) Dissatisfaction with the noise, c) Activities disturbed, d) Effects of other factors on dissatisfaction. The five-point scale, from (1) definitely satisfactory to (5) definitely unsatisfactory was applied to rate overall response and the results were evaluated both in individual and in group median dissatisfaction scores for correlation with the noise measures and different parameters. Despite of 1021 people had been interviewed, 525 questionnaire were able to be employed for this preliminary study as the rest were returned incomplete.

RESULTS OF PHYSICAL MEASUREMENTS AND SOCIAL SURVEY

Table 1,2 and 3 summarize the mean values of noise levels at each site. The severity of noise at those sites can be clearly seen when the results are compared with most of the noise limits internationally used. From detailed analysis of traffic noise, the following conclusions can be extracted:

1. Variation of traffic noise with the hour of the day is about max.2.5 dBA in L_{10} arising from rush-hours, but the difference within the weekdays is more prominent, i.e. in L_{10} value; 4-5 dBA and in TNI; 7dBA between Monday and Wednesday.
2. The highest concentration was found to be 7200 vehicle/hour and the highest percentage of heavy vehicle was 21% in Mecidiyeköy, a residential area which exposes to a part of the highway connecting the Bosphorus Bridge to E5 traffic road. The daily average noise levels imply this site to be the noisiest of the whole samples and they are also significantly higher than those obtained in different countries [1][2][3].
3. The correlation between the average traffic volumes and the noise levels at the sites where all the percentages of heavy vehicles remain between 10-21% has been indicated a raising regression curve up to L_{10}=76-78 dBA with the traffic volume. The effect of increasing volume becomes negligible afterwards (Fig. 1).

On the other hand the sound insulation properties of the exterior walls of the road-side buildings have been found to be much lower than STC 50 curve as it can be seen in figure 2.

The results of the preliminary analysis of the data obtained by social survey and the traffic noise measurements at 10 sites is briefly as follows:

1. In evaluation of the environmental quality, the noisiness have been expressed to be the fourth in the list, after the insufficiencies of social centers, parks and air-pollution causing by the traffic.
2. The intensity of dissatisfaction in terms of 5 point scale is given in figure 3. Except the ones in a relatively quieter site (no.9), the maximum amounts of individual dissatisfaction scores can be observed to be around 4 and 5 th degrees.
3. The calculated median dissatisfaction scores for each site including several reference points have been correlated with daily averages of L_{10}, L_{50}, L_{eq}, L_{NP} and TNI indices, and the good correlation have been obtained with L_{10}(r=0.849) and L_{eq} (r=0.857) which are quite close to similar investigations [1][4]. (Fig.4). However in this process, site no.6 has been remained out of the analyse since there, the dissatisfaction seems to be highly affected by visual influence of very dense traffic although the noise levels are not very high on the facades located 70 m. far from the road.
4. The noise disturbance on different activities while the windows are open, did not give satisfactory correlations unlike other studies [5] (Fig. 5). This situation can likely be explained by the difference in social levels, visual influencing, being out of the house in summer and the bedrooms at the rear side of the building.
5. The correlation between disturbance and the average traffic volume counted during the measurements is given in figure 6. The regression taking into account both the L_{10} value and the traffic volume yields below relationship (Q; vehicle/hour between 7.00-19.00 hours);

$$\% \text{ Disturbed people} = 0.006\ Q - 0.1113\ L_{10} - 61.52 \quad (r=0.639) \qquad (1)$$

DETERMINATION OF THE CRITERIA IN REGARDING TO NOISE CONTROL

The group median scores have been found to be correlated with the percentage of the people who expressed a general dissatisfaction with noise as given below; (X : group median dissatisfaction scores in five point scale.)

$$\% \text{ disturbed} = 1/(0.028-0.0035X) \quad (r=0.777) \qquad (2)$$

Thus the 4th degree of median scores corresponds to 73% of the disturbed interviewers and for this value, L_{10}=75 dBA and L_{eq}=72.5 dBA have been predicted from figure 4 to be able to propose an appropriate noise criteria for the existing sites within the city. By substituting this L_{10} value in figure 1, 1500 vehicle/hour can be estimated as a limitation on traffic volume. However, for future planning L_{10}=68.6 and L_{eq}=64.8 dBA which correspond to 3rd degree of dissatisfaction score should be taken as least tolerated levels considering the probability of yearly noise increase. Although, the first proposed criterion is

5-10 dBA higher than those internationally used, a different study basing them [6], has been proved that the cost of the additional insulation to the existing facades could not be afforded by most of the occupants who were seeking the solution in closing the windows and shutters or in using the rear-side rooms for every purpose.

REFERENCES

[1] Langdon, J.J. and Buller, I.B., "The Effects of Road Traffic Noise in Residential Areas", BRE Current Paper, 10/1977.

[2] Vallet, M. et. al., "Annoyance From and Habituation to Road Traffic Noise From Urban Expressways", J.Sound Vibration, 1978, 60(3), p.423-440.

[3] Keller, Y., Schaudinischky, L., "About Traffic Noise Levels in Developing Countries, Their Numerical Values and Their Prediction", Proc.of Inter-Noise 81, Oct.,1981, Amsterdam, p.557-560.

[4] Myncke, H., "Community Noise: A Field For Further Research", Tenth International Congress on Acoustics, Sydney,1980. Proc. p.105-115.

[5] Lamure, C., "Human Response to Traffic Noise", J.Sound Vibration, 1975, 43(2), p.377-385.

[6] Kurra, S., "Noise Control in Building and Environmental Designing Some Applications in Istanbul", (in Turkish), İTÜ.Fac.of Arch.Pub. (in print).

Table 1. Summary of the results related to traffic noise analysis

Site No	L_{10}	L_{NP}	L_{eq}	TNI	Disturbed %	Median score
1	81.6	86.1	80	68.8	100	5
2	69.1	74.6	67.7	58.1	88.9	5
3	78.9	87.5	76.2	83.4	84.7	4.5
4	73	77.3	69.8	66.7	64	3.6
5	77.5	83.6	75.3	71.4	73.8	4.1
6	75.3	80.7	73.2	67.1	65.2	4.3
7	76.9	83.3	74.4	73.8	51.4	2.8
8	65.3	71.5	63.0	60.9	61.5	3.5
9	71.3	78.5	68.0	73.3	70	3.2
10	76.4	84.5	73.8	75.8	72	4.6

Table 2. Average noise levels of aircraft noise

Site	NEF	PNL	NNR	CNEL	L_{dn}	L_{eq}
11	40	-	114.2	63.0	75	62
12	36	-	95.7	44.5	71	58
13	39	90.6	103.7	52.6	74	60

Table 3. Average noise levels of railroad noise

Site	PNL	L_{eq}	L_{dn}	CNEL
14	61.2	48.1	52.8	53.3
15	61.9	48.9	53.6	54.1
16	73.9	60.9	65.1	65.6
17	63.1	50.1	54.3	54.8

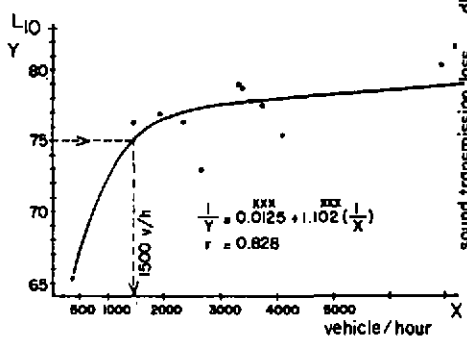

Fig. 1. Variation of noise levels (L_{10}) with traffic volume.

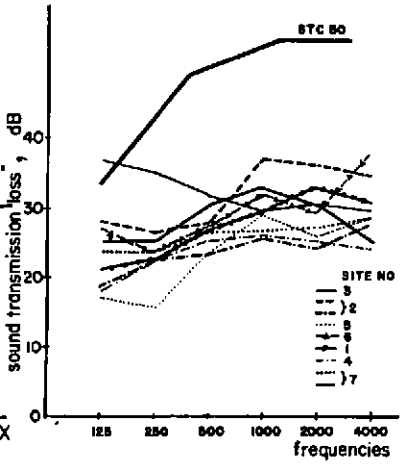

Fig. 2. Sound insulation properties of the facades at sampling sites.

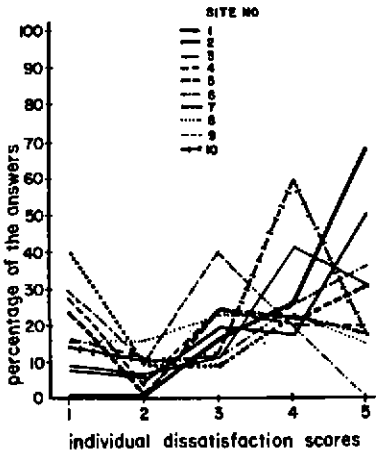

Fig. 3. Dissatisfaction from traffic noise related to sites.

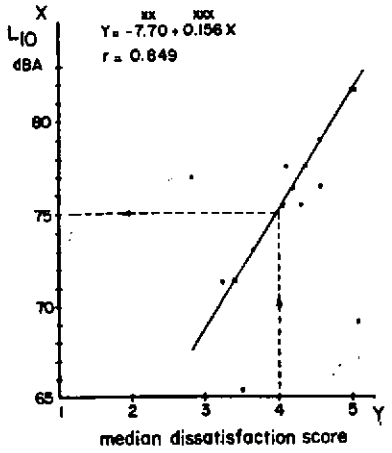

Fig. 4. Dissatisfaction related to noise level (L_{10}).

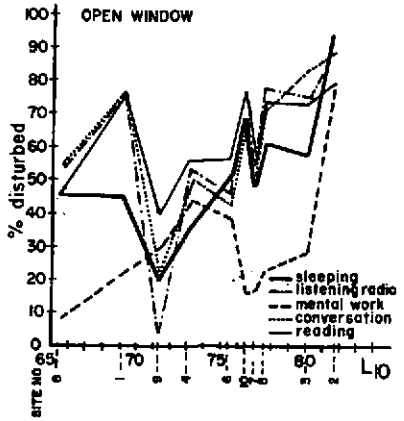

Fig. 5. Noise effects on activities while the windows are open.

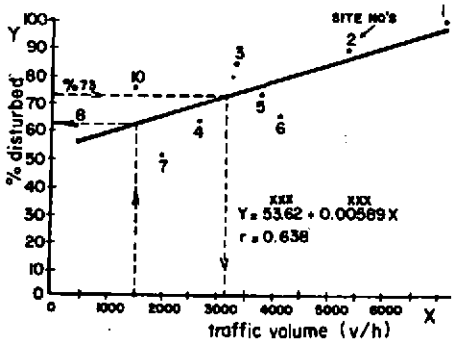

Fig. 6. Correlation between traffic volume and percentage of disturbed people.