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AN OBJECTIVE PARAMETER FOR THE ANNOYANCE OF ROAD TRAFFIC NOISE

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INTRODUCTION

Road traffic noise is one of the main sources of annoyance in the community. Annoyance is defined as the overall unwantedness of a sound heard in a natural situation[1]. It depends on many parameters which are discussed in many references such as[1],[2],[3]. In [2], the physical parameters of the noise which give a highly subjective impression of the unwantedness are: spectrum content and level, spectrum coplexity together with the existance of pure tones, duration and amplitude together with the frequency of level fluctuations. In [1],more factors have been mensioned such as : effect of time (day or night),emotional content,misfeasance, novelty and sociological influences . The studies of Franken [2] classified the annoyance factors into three types: the physical parameter of the noise, community factors and personal factor. The relation between these factors and the annoyance is usually determined through social surveys. In this paper a new parameter is introduced which could be considered as an objective factor among the other physical factors used to predict the degree of annoyance from traffic noise.

ANNOYANCE AND NOISE LEVEL FLUCTUATIONS

Many investigators have tried to correlate the physical parameters of noise with the subjective response of people [2], [4] . The noise climate [5] has been introduced , in an early approach, to describe the noise by factors other than the mean level. The noise climate indicates the range of noise level variations viz ($L_{10} - L_{90}$).
Importance of the fluctuations of the noise level lead to

Transient Peak Index (TPI) [5] , and Traffic Noise Index (TNI) [5] . These two indicies depend not only on the noise level but also on the quality of the noise, i.e. the degree of momentary fluctuation in its level. Robinson [5] suggested that L_{eq} is not sufficient to describe annoyance caused by fluctuating noise. Thus, he introduced the Noise Pollution Level (L_{NP}) in which fluctuations are represented by a weighting of the standard deviation of the noise level distribution about L_{50} . Voiget et al [5] concluded that L_{eq} and the cumulative L_{10} are the most appropriate parameters to predict the effect of the fluctuating noise on people. Moreover, they established an annoyance index which depends on L_1 and L_{99}. Straßen [6] considered that the principle components for annoyance are the higher frequency spectral components and the effective slope of the noise level.The effective slope is mainly related to the fluctuations of the noise level.
In this paper we obtain the power spectral density (PSD) of the noise level. This (PSD) may correlate the degree of annoyance due to traffic noise with its level changes.

EXPERIMENTAL RESULTS

We recorded the traffic noise in different sites in city Stuttgart, German Federal Republic.These sites have different traffic composition as well as different noise conditions. At the same time we obtained the different statistical noise levels $L_{n\%}$ by using noise analyzer B&K type 4426 together with the alphanumeric printer B&K type 2312. To obtain the spectral analysis of the noise level fluctuations ,we used the d.c. output from the measuring amplifier B&K type 2607 , which corresponds to the A-weighted level of the recorded noise, to feed the spectrum analyser type SD 375 dynamic analyser.
Since the road traffic noise is considered as a stochastic process [7] ,we used power spectral denisty (PSD) instead of the Fast Fourier Transform (FFT) [8] .
Figure (1) and figure (2) represent the obtained results for only two different sites in Stuttgart. The other results will be presented in another paper.

DISCUSSION AND CONCLUSIONS

Figure (1) shows the (PSD) analysis of the noise level fluctuations in Olga street . The recorded noise was from 7^{55} A.M. until 8 A.M. The measured value of L_{eq}=66.8 dBA. We notice that there is a discrete level fluctuation by 350 milli-Hertz (mHz). Figure (2) is the (PSD) for level

fluctuaions in Cannstatter street, which is one of the main streets in Stuttgart, the recorded noise is from 455 P.M. until 5 P.M. The measured value of L_{eq}=74.7 dBA. There is a remerkable component of level fluctuation by 250 mHz. From the results we conclude the following:
1- Level fluctuations have their peak value in the range of frequencies less than 50 mHz. These measured values are in good agreement with the theoretical values given by Kuttruff [9] for the characteristic fluctuation frequency of road traffic noise in residential area.
2- From fig. (1) we conclude that the level fluctuation with frequency = 350 mHz may cause annoyance in spite of the low value of L_{eq} , while in fig. (2) this discrete value is not present.The type of the noise in fig.(2) may not be so annoying as that of fig. (1) although its level is higher by 8 dBA.
3- To confirm that (PSD) analysis of level fluctuations is valid as an objective parameter for predicting annoyance due to road traffic noise, we need a social survey to get the corresponding subjective reaction of community.

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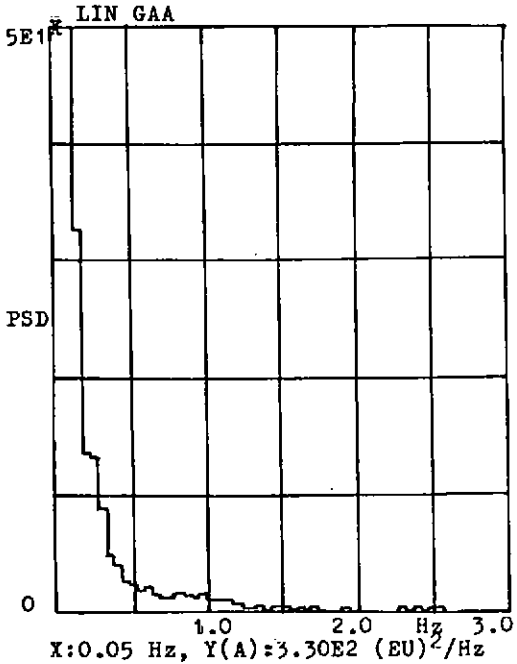
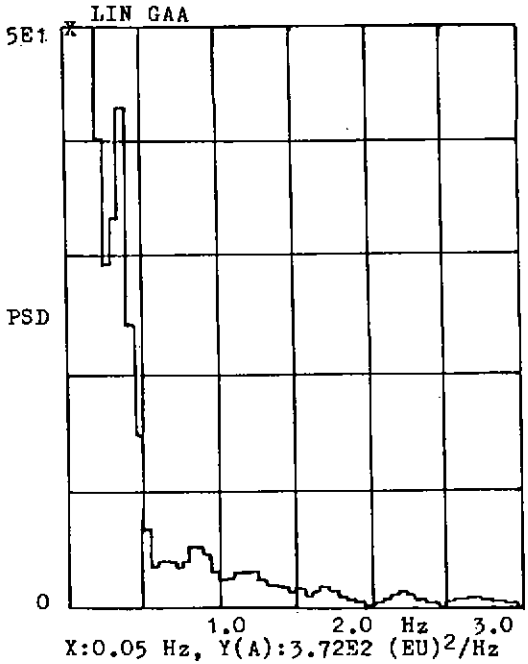


X:0.05 Hz, Y(A):3.30E2 $(EU)^2/Hz$

Fig.(2): PSD for Cannstatter str.



X:0.05 Hz, Y(A):3.72E2 $(EU)^2/Hz$

Fig.(1): PSD for Olga street