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ROAD TRAFFIC NOISE PREDICTION METHODS - STATE-OF-THE ART AND OUTLOOKS

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INTRODUCTION

Various kinds of predicting models /both deterministic and stochastic, simplified and sophisticated/ have been developed and utilized till now. The aim of this paper is to make a short review of approaches to making models and to give some details from the level of knowledge already achieved.

MODEL APPROACHES

In general two different approaches to solving the problem can be distinguished: microscopic and macroscopic. The microscopic one can be used at the modelling of the source behaviour and also of the environment characteristics. That is, one regards the individual sources using the time histories of single passing-by's, or the sound reflection and diffraction due to individual buildings and barriers, separately or both together. Such methods are more sophisticated and time-consuming but give more detailed answer to and deeper insight in the problem /e.g. [3],[4]/.

The macroscopic approach makes use models in which one neglects certain details such as speed or acceleration of single vehicles or actual building shapes and locations. One can predict average noise levels and receive information for average traffic conditions or larger areas /e.g. [7], [1o]/.

MODELLING TECHNIQUES

Three techniques of modelling have been mainly used in developing prediction schemes for traffic noise: experimental ones based on field measurements, scale modelling and theoretical modelling. At the first one the noise, traffic and side data are generally subjected to multiple regression analysis [7]. There is little control over the parameters affecting the noise level and interactions between the parameters can hardly be separated. Scale model techniques do not present absolute noise levels and some important properties of the environment can not sufficiently be modelled /e.g. ground effect, absorption coefficient/. Theoretical models are based on statistical distributions of the noise and traffic parameters or simulation of the traffic flow, followed the digital measuring technique, sampling of the noise levels to produce their cumulative distribution [1],[2]. This technique needs larger computers, time-consuming work but gives great freedom for users. Mainly in the latter case a general use of Leq term as noise index would make the calculations easier.

CLASSIFYING OF MODELS

One possible system of classification of the models is showed in Fig.1. Accordingly, the following models, built up on each other can be distinguished:

- freely flowing traffic, free noise propagation,
- disturbed flow, free noise propagation,
- freely flowing traffic, disturbed propagation,
- disturbed flow, disturbed propagation.

EVALUATION OF MODELS

Freely flowing traffic, free noise propagation

Some 15 years ago this type of models have been published first. All vehicles were assumed to move at constant speed, radiating the same sound power and being distributed on the road, equally spaced or, according to one of the statistical distributions /e.g. in [1] and [2]/. Almost all of the countries have already developed their own models only differing each other in the pass-by noise - vehicle speed relation relevant to the vehicle stock being in use in the country.

Disturbed flow, free noise propagation

The noise from urban traffic under interrupted flow condition depends on the acceleration /and deceleration/ of vehicles in great extent. Some publications dealt with the acceleration noise and/or including of it in the model /e.g. in [3]-[7]/.

An example has been given in Fig.2. and 3. [8]. The Leq values, referring to one passing-by and one hour are depicted for cars and buses over the acceleration, making an integration in the speed range from v=0 to v=vmax, assuming that the maximum speed is achieved just before the observer's point. This part of the whole integral is generally the dominant one and can be used to investigate the relationship between the Leq level and the traffic composition /See Fig.3./. This model is however a macroscopic type and do not enable to predict the levels in the very near of intersections /under 5o m/.

Nevertheless, problems have been raised at applications because of the lack of individual or average values of acceleration at planning stage and the lack of general models applicable to all situations appearing in the traffic.

Other parameters expressing the disturbances of flow /level of service, etc./ have been failed. Otherwise there is a discrepancy between the noise type approval value of the vehicles gained by the existing standards and the input data needed by the prediction models.

Freely flowing traffic, disturbed propagation
The models developed /e.g. in [9]/ are based on transfer function giving the sound levels in built-up situations produced at the observer position by a single vehicle moving along the road and recorded as a function of the distance along the road /microscopic approach/. The main problem is the gaining of the individual transfer functions, which can also be made by a scale model of the different urban situations /hybrid models/.

Using the macroscopic approach the space between buildings can be characterized by repeated scattering of sound energy by the buildings and that space is idealized by three or two dimensional model [1o].

Disturbed flow, disturbed propagation
This complex situation, appearing mostly in the real urban traffic can not be modelled sufficiently yet. Some parts of it have been published isolatedly [9] but at the present only experimental methods, using the multiple correlation technique[7] are available.

CONCLUSIONS

Regarding the present state-of-the art of traffic noise prediction methods, it can be stated that only the first model /according to Fig.1./ is completely developed and the last one is actually undeveloped.

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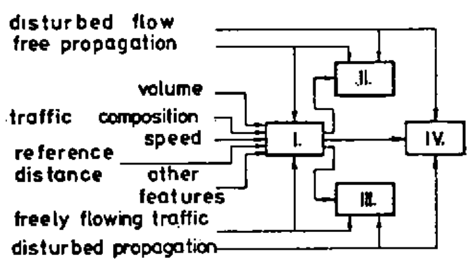

Fig. 1.

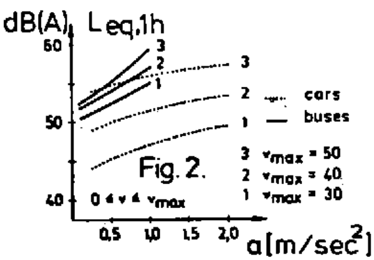

Fig. 2.

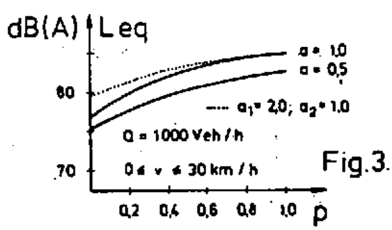

Fig.3.