ACOUSTIC PARAMETERS DESCRIBING THE TRAFFIC NOISE AS THE INPUT DATA FOR EVALUATION OF THE SOUND REDUCTION OF THE FAÇADE

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1. Introduction

One of the manners which leads to assurance the suitable acoustic comfort in rooms running a risk of the trafic noise is the adequate planning of the façade. For the assessment of the demanded sound insulation we have, at first, to evaluate the external noise levels appearing in the vicinity of the building. The basic parameter used for acoustical planning is the long time average A-weighted sound pressure level for a specified period T ($L_{Aeq,LT}$). In the project of the EC Directive [1] concerning the preparation of the noise maps which are used, among the others, for the evaluation the sound insulation of the façade, two long-term noise indicators L_{den} and L_{night} are recommended. Important questions are: "shall the proposed indicators L_{den} and L_{night} be sufficient for the estimation of noise impact on people's health and well-being?" and "which noise indicator has to be taken into account for the selection the sound reduction of the façade?".

2. Acoustic parameters of traffic noise – its classification and methods of determination

The basic parameter used for evaluating the traffic noise is the equivalent continuous A-weighted sound pressure level for a specified time interval T, $L_{Aeq,T}$. The time interval has to cover the typical human activities and variations in the noise propagation. In general, it is one day (16 hours) and one night (8 hours).

However, both in day and at night, the noise level in the environment changes depending on the day of the week or of the season of the year (e.g. due to diversified intensity of road traffic or diversified atmospheric conditions). Therefore, in order to describe the ambient noise in the best possible way, it should be taken into account the long - term interval, which can last a week, a month, a number of months or a year. In this case, the acoustic parameter is the long term average sound level $L_{Aeq,LT}$. Noise measurements (or calculations) prepared on the basis of the long term average sound level $L_{Aeq,LT}$ can refer to day, to night or to full 24 hours.

In the project of the EC Directive, presented in the autumn of 2000, there is a proposal of using two „noise indicators" - L_{den} and L_{night}. The primary noise indicator is the day-evening-night level L_{den}, which is an indicator for „annoyance". This quantity is closely related to the day-night level L_{dn}, which is used in some countries in Europe and in the USA to characterize aircraft noise. The difference relies on the introduction, in addition to day and night, of afternoon period.

Overall night-time noise indicator L_{night} is an additional indicator which shows the degree of sleep disturbance.

Apart from $L_{Aeq,T}$ and $L_{Aeq,LT}$, one can also apply other parameters directly related to them, namely percentile levels $L_{AN,T}$ (the level $L_{Aeq,T}$ that is exceeded for N% of time T).

The values of noise indictors can be determined either by measurement or by computation.

The principles for long-term average measurements are presented in ISO 1996 -1:1982 and ISO 1996 – 2:1987 [2]. The averaging over a year, demanded in EC Directive, requires special attention. The fluctuations of noise indicators values are caused by the fluctuations of the sound emission and by the fluctuations of the sound transmission. So, it is recommended to take into account the influence of meteorological factors like temperature and wind.

By reason of the difficulties with measurements of the long-term average sound levels (much more time-consuming and expensive), the computation methods will play in practice a dominant role.

The used software should meet the following basic requirements: set the acoustic parameters appropriate for the needs, contain area modeling facilities and contain noise propagation calculation facilities, taking into account the fluctuations introduced by the effect of meteorological factors.

An example of solution to this complex problem of including the meteorogical conditions in the calculations is the method "NMPB" developed in France [3] and applied in the „MITRHA" program prepared by the CSTB.

3. Selection of the sound reduction of the façade

Protection of rooms against the traffic noise is realizad by the suitable selection of the sound insulation of the façade. The sound level difference of the façade should be sufficient for the assurence that the A - weighted indoor sound level will not exceed the value required by the standard regulations. This condition can be expressed with the help of the one of the following realtions:

$$D_{2m,nT,w} + C_{tr} \geq L_{A1,2m} - L_{A2,nT} \quad (1)$$

or

$$D_{2m,n,w} + C_{tr} \geq L_{A1,2m} - L_{A2,n} \quad (2)$$

where

- $D_{2m,nT,w}$, $D_{2m,n,w}$ - the weighted standardized or normalized sound level difference of a façade, dB
- $L_{A1,2m}$ - the outdoor A-weighted sound pressure level, 2m in front of a façade, dB
- $L_{A2,nT}$, $L_{A2,n}$ - the demanded indoor A-weighted sound pressure level, standardized to 0,5 s reverberation time or normalized to 10 m^2 absorption, dB

In many countries (including Poland), the standard requirements concerning the indoor sound level of the traffic noise are formulated with using the equivalent A-weighted sound pressure level $L_{Aeq,T}$ for a specified time interval T (16 hours of day and 8 hours of night).

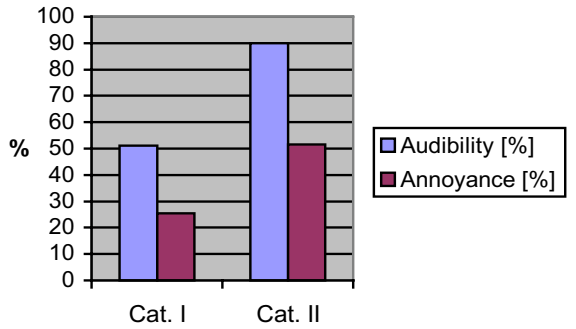
4. Subjective evaluation of the traffic noise

The standard requirements are defined in order to assure the suitable acoustic comfort in rooms. Therefore they should refer to the subjective evaluation of noise.

Dose-effect relations should be determined on the basis of public opinion surveys. A considerable number of such surveys has already been carried out.

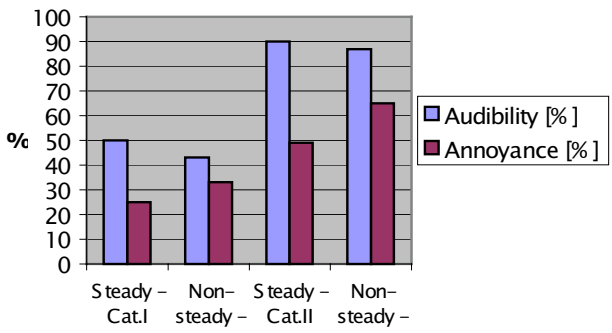
The Polish experience [4,5] shows that the audibility and the annoyance of traffic noise in dwellings is felt first of all during the night-time. The sensibility of noise is depending on the difference between the existing and required indoor sound level (category I - $\Delta L_{Aeq} < 3$ dB category II: $\Delta L_{Aeq} \geq 3$ dB). In cases, when the indoor level L_{Aeq} exceeds the required value 30 dB more than 3 dB, the annoyance increase about two times (fig.1).

Fig.1 The subjective assessment of traffic noise penetrating the dwellings during the night-time



The another conclusion from the results of the survey carring out among the inhabitants is the difference between the subjective evaluation of steady and non-steady noise. Despite the slightly less audibility, the annoyance of non-steady noise is greater (fig.2).

Fig.2. The subjective assessment of steady and non-steady noise in dwellings during the night-time



The Austrian research [6] concerning the similar matter have proved that the best correlation (with correlation factor 0,99) have been occurred between evaluation of noise annoyance and the quasi-maximal level L_{A10}. It seems to be very motivated especially in the case of appearing the noise caused by tramway traffic, when the noise level L_{Aeq} is not so high but the people feel it as annoyed.

5. Concluding Remarks

In autumn 2000, the European Commission prepared a proposal of a Directive relating to the assessment and management of environmental noise.

The Directive included a number of arrangements for the unification of measurements and calculations. The wide discussion on that subject has started. It concerns the recommended indicators and their practicability for the set goals (including the planning of the sound insulation of facades in respect of assurence the people's well-being inside a building and the evaluation the best corelated dose-effect relations) .

Important question is: in case of characterizing the audibility and annoyance of traffic noise, shall the proposed indicators L_{den} and L_{night} be sufficient? Is there a need for the introduction of additional indicators which would characterize short-term noise of substantial level?

The results of the survey investigations [4,5,6] have shown that annoyance of noise is dependent not only on the time average sound level A, but primarily on its maximum value (especially for the night time). It seems to be justified the use the quasi-maximal level outside and inside of building (L_{A10}) for the evaluation of the sound insulation of facades, because this parameter is better corelated with subjective evaluation of audibility and annoyance of the traffic noise.

This conclusion is conformed with one of the amendments of Parliament (accepted by EC), concerning the maintaining and adopting usuful national noise indicators for acoustical planning [7].

References

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