inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 6.8

SIMPLIFIED CHARACTERISATION OF NOISE EXPOSURE TO TRAFFIC NOISE IN URBAN AREAS

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Keywords:
NOISE EXPOSURE, URBAN, MAPPING, MODELLING

ABSTRACT
As a part of our activity as an acoustical studies office, we have to quantify the roadside residents sound exposure on large territories: research of critical noise areas along noisy roads or noise exposure mapping of the most urbanised areas. Methods to evaluate noise levels have been developed and improved thanks to: i) large measurement campaigns on territories representative of urban diversity; ii) tests of the incidence of various parameters on theoretical cases modelled on acoustical software: insertion of the road in its natural environment (cross-section, more or less favourable propagation conditions) and in its built environment (height, density, orientation of the neighbouring buildings ...). In middle-urban areas, the control of traffic parameters is good and allows a relatively reliable approach for the noise levels calculation, at least in direct border of the roads. In cities, the traffic volume is not the most important parameter: the streets must be classified according to their function and their specific traffic and flow characteristics, linked to the local organisation of traffic flows and to the urban areas typology. The present paper summarises two studies: i) noise exposure in critical noise areas; ii) urban noise mapping.

1 - CLASSIFICATION: ENVIRONMENTAL NOISE

As a part of our activity as an acoustical studies office, we have to quantify the roadside residents sound exposure on large territories: research of critical noise areas along noisy roads or noise exposure mapping of the most urbanised areas.
Methods to evaluate noise levels have been developed and improved thanks to:

- large measurement campaigns on territories representative of urban diversity
- tests of the incidence of various parameters on theoretical cases modelled on acoustical software: insertion of the road in its natural environment (cross-section, more or less favourable propagation conditions) and in its built environment (height, density, orientation of the neighbouring buildings ...).

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In cities, the traffic volume is not the most important parameter: the streets must be classified according to their function and their specific traffic and flow characteristics, linked to the local organisation of traffic flows and to the urban areas typology.
The present paper summarises two studies:

- noise exposure in critical noise areas
- urban noise mapping

2 - NOISE EXPOSURE IN CRITICAL NOISE AREAS

The large noise classification process of the most circulated roads (threshold of 5000 vehicles per day) done on the entire French territory, can be used to characterise the noise exposure of the neighbours of these road axes, so as to define priorities of resorption of the critical noise areas on the entire territory.

An exploratory study as been implemented on the main roads network of the Loire department to evaluate all the buildings exposed to day noise levels above 70 dB(A). This study benefited of a financing from the Environment Department.
The idea was to test the incidence of the three following crossed parameters:

- profile of the road
- density of built area
- floor

on the exposure of buildings close to noisy roads.
A database "decrease" has been built from modelling of sample cases on MITHRA software: flat ground, embankment, sunk, cutting, screen, according to the number of traffic lanes and the propagation conditions (meteorology)
The decrease for an embanked 2 ×2 lanes acoustically saturated, with or without screen, with day or night propagation conditions is illustrated Figure 1.

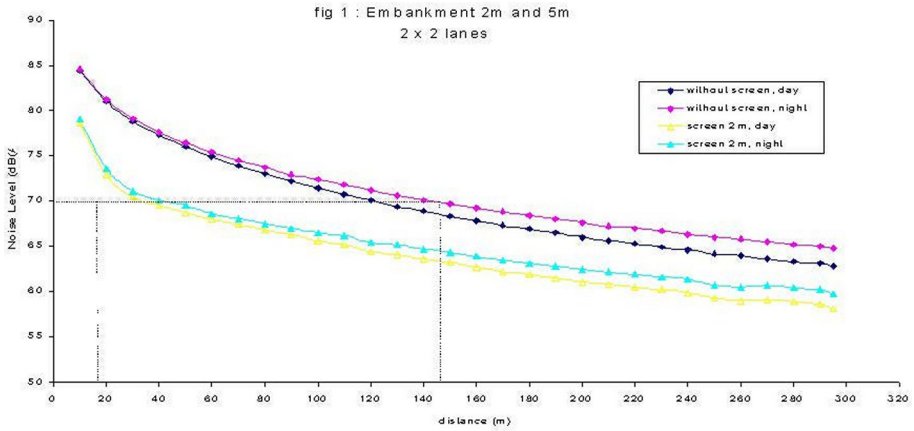

Figure 1: Noise levels decrease in terms of the distance to the road.

Knowing the reference noise level of the road, the critical isophone position of each configuration and the territory that can be concerned by an overstepping of the critical threshold can be determined.
The modelling of the building positioning (one floor housing development type) according to the density and the relative implantation of the buildings permitted to define a noise penetration degree, defined as a ratio between the number of habitations concerned by the critical threshold overstepping, and the total number of habitations situated within the critical isophone. This ratio has to be modulated around 0.5, except for an embanked road where it is equal to 1 (propagation already very limited without buildings).
The confrontation between results and in situ measurements confirmed that buildings create an important obstacle to the noise penetration and that for most of the cases, only the first row of housings can have day noise levels above 70 dB(A).
However, the number of floors is a very important factor of the noise level variability already identified by calculation: 5 dB(A) is a common difference between ground floor and last floor of a building, and the absorbing effect of the ground is even more sensitive on the measured levels than on the theoretical calculation.
Figure 2 shows the distribution of measurements according to distance and floor. A very large dispersion of results is obtained on the lowest floors corresponding to very varied cases. As a whole, we observe widely higher noise levels on high floors or for an embanked road.
A direct approach on the first exposed housing row, even farther than the isophone, with a ponderation according to the floor and the road profile is relevant. It permits us not to forget a building remote but high and directly exposed, not to account dense built area in which the noise penetrate only a little and to modulate according to the floor.
This approach is now in progress.

3 - URBAN NOISE MAPPING

Following a demand of the Roche sur Yon town council, a mapping of the entire communal territory has been realised, it is based on an evaluation of the urban noise ambiences completed from an assessment

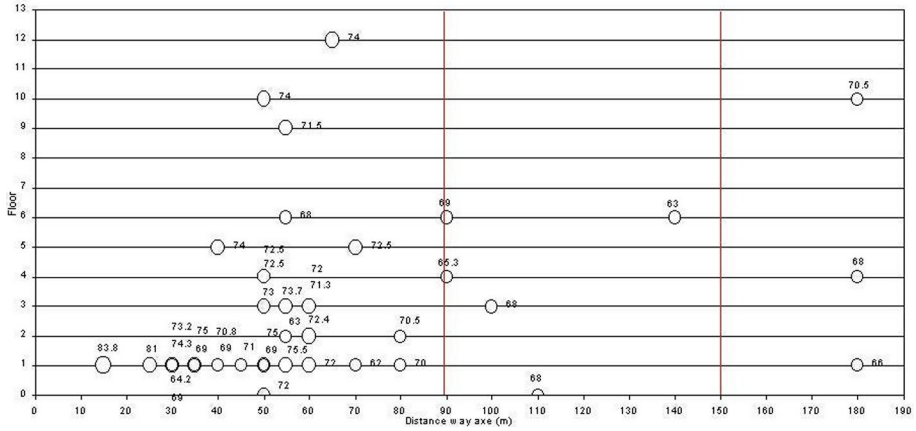

Figure 2: Distribution of measurement points in front of a building directly exposed to the noise of a dual carriageway acoustically saturated.

carried out by the local Environment service and a large acoustical measurements campaign: 54 points on 24 hours distributed on the entire territory, and also shorter sound recordings.
This work is part of a revision of the urban planning map. Taking the noise into account should permit a better management of the noise nuisances prevention as it can be a communication tool between town councillors, economic and social actors and local population.
Such a map can act as a reference, as a photography done at a special time would do, to follow on a long term the noise environment of the town.
The noise environment is particularly complex in the urban areas where sources and actors are numerous and the diversity of the urban environment generates a permanent background noise, a "rumbling" of the town that penetrates everywhere and from which traffic noise is an important part.
The acoustical study conducted on the Roche sur Yon territory focused on gathering a maximum of objective noise data determined from measurements. Thus a reference noise state is defined in pilot areas chosen as representative of the diversity of the exposure to traffic noise. All the gathered elements can be extrapolated to the entire territory by a typology study on the different types of noise sources and urban frames.
The identification of the principal noisy roads and their acoustical characterisation was the first work. It was based on a hierarchical classification of the road network.
The road categories were as follows:

- Urban expressway: it consists of national or departmental roads which support transit traffic that can have a lot of lorries throughout the town
- First circle bypass concerning circle boulevards of town which support traffic linked with home/work displacements but also lateral transits
- Town centre protection circle
- Town centre access roads
- Peripheral quarters access roads

Each type of road has flow characteristics highly linked to the structure of traffic and its insertion in the urban frame.
In dense urban areas, the classical law 10 log (traffic) does not apply.
All the measurement points were used to define categories in order to give a reliable estimation on the average noise level in front of a near-by housing. This classification takes the average distance between road and housing and the reflection effects of buildings into account.
The table below gives the most significant results for the Roche sur Yon town.

Category	Average LAeq-10log(traffic)	Standard deviation
Urban expressway	31.2	0.5
Access to the centre	28.8	0.1
First circle bypass	27.4	0.4
Expressway in periphery	25.5	0.2
Centre circle	25.3	0.6

Table 1.

We observe hierarchically distributed noise exposure of the neighbours directly near the road.
When the buildings are far from the road, standard calculations have been implemented on MITHRA software in order to test the incidence of the protecting effect of buildings and to define a mean position of the isophones 60 and 55 dB(A).
We can see the impact of traffic noise on the final mapping showed on figure 3. The basic color of the road shows the real exposure of direct neighbours and not the acoustical power brought back to a fictitious facade. The areas with acoustical impact are coloured.

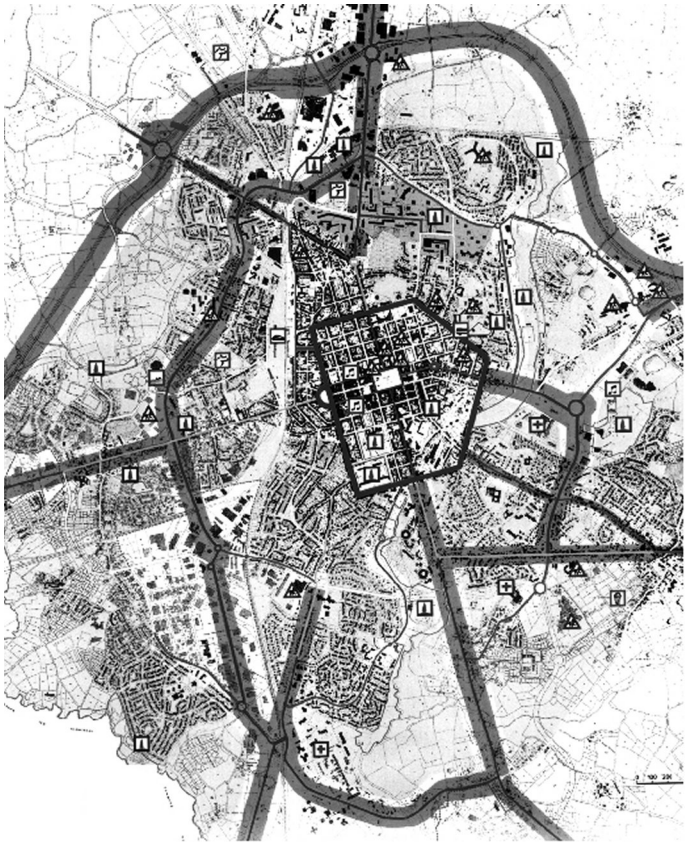

Figure 3: Example of urban noise map.

4 - CONCLUSION

From the various studies conducted using in situ results, it is now possible to give reliable answers on the exposure of noisy infrastructures neighbourhood without the need of heavy calculations and then to proceed to a global analysis of a territory leading to a reliable hierarchical classification of problems.