Case Study of Noise Reduction in Urban Road Transportation

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Abstract: - A major source of noise in an urban agglomeration is the road traffic. In order to analyse the effect of the noise on the population, the local authorities need noise maps, designed depending on each major noise source. In order to measure the noise generated by the road traffic several data are necessary to take into consideration: number of vehicles and their speed selected by category, and data related to the road segment, as well: traffic flow, road surface construction and gradient. This research paper intends to make a case study on the methods of reducing noise of the urban road transport in Braşov city. The calculation method by modelling the road noise using LimA v 5.2 software and finally the resulted noise maps for Lden and Ln are presented for two particular cases: porous asphalt and speed reduction from 60km/h to 50km/h.

Key-Words: - Urban noise, noise map, road transportation, porous asphalt, noise modelling.

1. Introduction

Prediction noise is a major source of dissatisfaction in residential areas. There are many noise sources in the urban areas, but only some of them can be taken into consideration for noise mapping and noise reduction action planning. These are: road traffic, railway traffic, airports and industry. In order to know the effect of these noise sources on the population and buildings, we have to know as much as possible about the sources and propagation. The analysis can be done using specialized software. The result is a noise map – a map representing the noise levels as surfaces or contour lines. The input data for the simulation software are a base map and specific properties of the sources - road segments, railway segments, industrial sources and others. The core of the software system used to generate the noise map was LimA 7812. LimA is a powerful noise calculation system. It includes advanced automated data manipulation, geometric handling and allows the user to perform large and accurate noise calculations from existing data sets. In theory, is not necessary to use other software, such as GIS and AutoCAD. In fact, the data and geometry manipulation features are not so powerful and do not gives enough flexibility. But a positive point is that Lima has import and export features. When the final result is a noise map, another software system mandatory is GIS software. The cost of a GIS system is also high and, on the other hand, not all features of such software are useful in noise mapping. In the figure below the map of the studied area from Braşov City.

Fig. 1. The map of studied area in Braşov City

2. Preparing data for calculation and data acquisition

The preprocessing phase includes the activities for preparing LimA input data: the layers of GIS map (streets, terrain model, buildings, and other obstacles) and noise sources data: traffic volumes, vehicles speed, flow type, road surface and gradient. All these data are stored in an Access database; this is imported in LimA over the base map. The post processing phase is based on the ERT files created by LimA. These are text files and contain a line for each point of the calculation grid.
All the base map layers were drawn in AutoCAD, and the custom functions for pre- and post-processing the data was written in AutoLISP, using extended ActiveX functions available for storing metadata.

For the data acquisitions, Bruel & Kjaer 2250 sound level meters and SDR Doppler radars were used.

As mentioned before, the input data for the simulation software are stored in Access tables, which are connected to the AutoCAD drawings using the entities handle. The base map layers are imported in Lima through DXF files. For the buildings, the height information is sent as color property (the conversion between thickness and color was done previously on the AutoCAD drawing). After importing the geometry some checks should be done in LimA: closing polygons to ensure the correct modelling, especially for buildings; recognizing and preventing multiple existences of objects; linking objects to prevent gaps in the model; smoothing polygons to reduce the number of vectors and speed up calculations.

The streets layer is composed of open polylines. Since each segment should contain specific data related to vehicle traffic, it was decided to use a single line entity for each street segment. The noise mapping software accepts both polylines and lines. Each line entity has the traffic data associated as custom properties, or metadata. There are three types of streets: main streets, connection streets and residential streets. The traffic data for residential streets are the same for all the segments, and also for the connection streets. In case of the main streets, traffic data were collected or estimated for each segment, and there are more metadata associated.

3. Modelling of urban road noise - case study: porous asphalt

Road surfaces influence the generation of noise by tyre-road interaction and the propagation of noise from the vehicle engine and transmission system. Silence asphalt has an open structure with about 20-25% air void inbuilt. As a result, it absorbs noise and drains water, thus increasing road safety.

As an economic implication the silence asphalt surfaces cost about 30 EUR/m² more than conventional surfaces. Compared to other noise abatement measures (like barriers, sound proof windows), the costs for low-noise road surfaces remain relatively low [16].

The advantage of silence surfaces is reducing pavements in the ongoing pavement maintenance process and thus it is a cheap and simple noise abatement measure to implement. The replacement of road surfaces can be done on short notice. No compliance of drivers is required to make this measure fully efficient. In most cases, low-noise surfaces reduce the rolling resistance, thus they might decrease fuel consumption as well.
Good craftsmanship and accuracy in the laying process are important to achieve the best results. No special maintenance has to be performed on thin layers. For porous surfaces, cleaning is necessary on a regular basis. Once the surface is strongly clogged, cleaning has no more impact on the noise performance. Attention has to be paid to maintenance and repair. Discontinuities reduce the noise reduction effect, at least locally.

However, experience shows that reducing speed limits by for instance 10 km/h (only) through posting new or changing existing static speed limit signs has little or no effect on actual driving speeds. The use of variable signs for posting speed limits or informing drivers of their speed is more effective than static signs when it comes to reducing driving speed. The speed reductions vary from location to location, and therefore effects on noise will also vary [16].

4. Modelling of urban road noise - case study: speed from 60km/h to 50km/h
As reductions in driving speed have substantial effects on traffic noise emissions, especially at urban speeds, lowering speed limits appears to be a feasible approach to reducing noise emissions from road traffic. Speed reductions on certain roads or for complete areas are also possible. 30 km/h-zones are more frequent. Another concept for residential areas is the one of the home zones where priority is given to non-motorised users. Speed limits are well below 30 km/h, sometimes as low as walking speed, which is about 3 to 5 km/h.
Table 1 Noise level in different measuring points for the case studies

<table>
<thead>
<tr>
<th>Simulation</th>
<th>Indicator</th>
<th>Rec1</th>
<th>Rec2</th>
<th>Rec3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial situation</td>
<td>Lden dB(A)</td>
<td>77.1</td>
<td>84.5</td>
<td>80.7</td>
</tr>
<tr>
<td></td>
<td>Ln dB(A)</td>
<td>67.6</td>
<td>78.2</td>
<td>74.4</td>
</tr>
<tr>
<td>Porous asphalt</td>
<td>Lden dB(A)</td>
<td>74.1</td>
<td>81.5</td>
<td>77.7</td>
</tr>
<tr>
<td></td>
<td>Ln dB(A)</td>
<td>64.6</td>
<td>75.2</td>
<td>71.4</td>
</tr>
<tr>
<td>Speed 50 km/h</td>
<td>Lden dB(A)</td>
<td>76.2</td>
<td>84.1</td>
<td>80.1</td>
</tr>
<tr>
<td></td>
<td>Ln dB(A)</td>
<td>66.6</td>
<td>73.8</td>
<td>73.8</td>
</tr>
</tbody>
</table>

5. Conclusion
The reduction of noise through the use of porous asphalt compared with the initial situation as it is shown in Table 1 is about 3 dB (A), which is a significant reduction.

A speed reduction measurement should lead to a sufficient decrease of speed without drivers changing to a lower gear, which could increase noise levels. Another problem is to make drivers comply with the speed reduction measures. Static signs are comparably cheap (costs about 300 EUR per sign) whereas variable signs are quite cost-intensive. Installation of an ATC (automatic traffic control system) is comparably expensive, but costs can be covered with the fines after implementation.

In general, reducing speed will also contribute to road safety and an better quality of air.

References:

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