Study Regarding the Noise Mapping Of Tg. Mures Urban Transportation

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Abstract: - Studies have shown that some of the most pervasive sources of noise in our environment today are those associated to transportation. Prediction methods for environmental noise from rail and other sources have been used for more than two decades now in several Member states. The research paper intends to interpret the noise map of the rail transport of Tg. Mureş city. First of all the parameters influencing the rolling noise and traction noise is analysed. In the second part of paper it is presented the calculation method, modelling the rail noise using LimA v 5.2 software and finally the resulted noise maps for Lden and Ln.

Key-Words: - Urban noise, noise map, rail transportation, noise barrier, noise modelling.

1 Introduction
Prediction methods for environmental noise from rail and other sources have been used for more than two decades in several Member states. A survey made on behalf of the Noise Policy Working Group no. 3 on Computation and Measurement concluded that none of the existing models is completely adequate for future use as the common European standard. Harmonised method for the assessment and management of environmental noise representing an essential condition for the new EC Directive is the goal of the HARMONOISE project. Two indicators have been introduced in the Directive's text: Lden and Ln. The former is defined as follows [9][10][7]:

\[
L_{den} = 10 \times \log \left( 12 \times 10^{10} + 4 \times 10^{10} + 8 \times 10^{10} \right)
\]

A good knowledge of the nature and relative strengths of the various sources of noise is a fundamental requirement to understand, and moreover to reduce, railway noise. In the section below, the parameters influencing the rolling noise and the traction noise will be described.

1 Rolling noise
The parameters influencing the rolling noise can be divided into three categories [10]:

1) Parameters influencing the noise generation
   - Roughness
     - Type of braking system and wheel maintenance
     - Rail maintenance
   - Contact patch
     - Wheel load
     - Wheel and rail profiles
   - Number of wheels
   - Wheels and rails defects
   - "Parametric excitation"
     - Train speed
     - Sleeper spacing
     - Statistical variation of mechanical characteristics of track components

2) Parameters influencing the track radiation
   - Wave propagation
     - Vertical and lateral decay rates
     - Rail pad stiffness and damping loss factor
   - Radiation efficiency of track
     - Rail
       - Foot width
       - Lateral inertia
       - Mass
     - Sleeper
       - Radiating surface
       - Mass
       - Type
       - Spacing
3 Calculation method and data acquisition

Prediction methods for environmental noise from rail and other sources have been used for more than two decades. In the research paper, the Dutch model in which the source is given as an equivalent sound power level per kilometre track, calculated for eight octave bands from 63 to 8000 Hz was used. The Dutch model uses two line sources above each other at 0 and at 0.5 meter above the rail head, situated in the middle of the track. Category 9 (high speed train) is modelled with four line source heights (0.5, 2, 4 and 5 meters) [12].

For modelling propagation the line sources are split into segments having an angle of a maximum of 5° seen from the receiver. The emission for each octave band is calculated as a value \( a \) (dependent on category and frequency). The speed dependency is incorporated as \( b \cdot \log(v) \), where \( b \) is a constant given per octave band, source height and category. Corrections can be made for superstructure, braking and bridges. The emission of each octave band is calculated according to:

\[
E = a + b \cdot \log v + 10 \log Q + c. \tag{2}
\]

Where:

- \( v \) = train speed
- \( Q \) = number of coaches per hour

Correction for superstructure is separated in correction for track construction and correction for joints. Roughness is not included. Correction for steel bridges makes distinction between rolling noise and bridge noise. 9 Categories are distinguished, based on measurements and train type.

Most correction values are category- and frequency dependent. The result is an equivalent sound power level per coach for two (or five) heights [10]. In the table below you can see the correction coefficient for different type of trains [5].

<table>
<thead>
<tr>
<th>Romaian rail agency Cod</th>
<th>LimA Cod</th>
<th>Nr of coach according to OM 1830</th>
<th>Real nr of coach</th>
<th>Cod (CAT) Dutch method SLMII</th>
<th>Nr of coach according to SLM II</th>
<th>Correction coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC</td>
<td>IC01</td>
<td>2</td>
<td>1+2</td>
<td>8</td>
<td>1+3</td>
<td>0</td>
</tr>
<tr>
<td>R</td>
<td>R01</td>
<td>10</td>
<td>1+4</td>
<td>8</td>
<td>1+3</td>
<td>+1</td>
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<td>10</td>
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<td>8</td>
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<td>-1.3</td>
<td>-8</td>
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<tr>
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<td>1+6</td>
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</tr>
<tr>
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<td>-8</td>
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<tr>
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</tr>
<tr>
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<td>1+1</td>
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<td>-8</td>
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<tr>
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<td>P05</td>
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<tr>
<td>LV</td>
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</tr>
<tr>
<td>PRA</td>
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<td>4</td>
<td>1+4</td>
<td>+7.1</td>
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<td>1+0</td>
<td>6</td>
<td>1+0</td>
<td>0</td>
</tr>
</tbody>
</table>

It may be noted that each train category was assigned a special code, as it can be observed in (column 2), named LimA code, the length of the whole train is defined by the motor unit (Lok) and actual number of wagons (e.g. 1+3).

### Table 2: Train circulation at Tg.Mureș Center Station - Tg.Mureș North

<table>
<thead>
<tr>
<th>ID</th>
<th>LimA Cod</th>
<th>Name</th>
<th>N.Day</th>
<th>N.EVENING</th>
<th>N.NIGHT</th>
<th>Category</th>
<th>Lok/Rag</th>
<th>Speed</th>
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<td>1</td>
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<td>9</td>
<td>13</td>
<td>120</td>
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<tr>
<td>R</td>
<td>R01</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>R02</td>
<td>R02</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>120</td>
<td></td>
</tr>
<tr>
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<td>R03</td>
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<td>0</td>
<td>9</td>
<td>11</td>
<td>120</td>
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</tr>
<tr>
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<td>1</td>
<td>5</td>
<td>15</td>
<td>120</td>
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</tr>
<tr>
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<td>A02</td>
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<td>0</td>
<td>5</td>
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<td>120</td>
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<td>0</td>
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<td>0</td>
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<td>120</td>
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<tr>
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<td>LIM01</td>
<td>2.38</td>
<td>0.72</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td>90</td>
<td></td>
</tr>
</tbody>
</table>

4. Modelling of rail noise

In the figure below, some examples of content windows for input data entry module of the program LimA for rail traffic, according to the method of calculation Dutch SRM 2 are shown.
The railway alignment segmentation was made at 100 m in areas where there are significant variations of speed (e.g. switch). There was no need for values less than 100m as the radii of curvature are large enough. The segmentation criterion is the speed limit allowed on each section of rail that was communicated by the railway association.

Consequently, the congestion at the Tg. Mures station is done by segmentation, by covering areas in various stages of reduction gears by passenger trains.

In the figure below, the resulted urban rail noise map for Lden and Ln is shown.

Fig. 1. Data implementation in LimA software

Fig. 2. Rail segmentation

Fig. 3. The resulted urban rail noise map during day-time

Fig. 4. The resulted urban rail noise map during night-time

The calculation of population could be made easily if, for each building along the railway, the number of inhabitants is known. The noise map allows identifying the exposure of each façade of the building to each noise level. The figure below presents the number of inhabitants.
exposed to the noise generated by the rail transportation for Lden and Ln.

![Population exposed during day-time](image)

Fig. 5. Population exposed during day-time

![Population exposed during night-time](image)

Fig. 6. Population exposed during night-time

5. Conclusion
As you can observe in Fig. 3 and Fig. 4, Tg. Mureş city has one line of rail emission. The resulted noise maps shows a relatively normal noise level; the limits for Lden is 70 dB (A) and for Ln is 65 dB (A). One solution could be that along the rail line where the buildings are close to one another, noise barriers could be mounted. At the same time, the local authorities could decide to decrease the noise level, as it involves much higher costs.

References:

ACKNOWLEDGMENTS
This paper is supported by the Sectoral Operational Programme Human Resources Development (SOP HRD), financed from the European Social Fund and by the Romanian Government under the contract number POSDRU POSTDOC-DD, ID59323.