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Analytical Calculation of Vehicles Noise in the Road Traffic and Graphical Presentation

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Abstract: Noise in general is considered a concern of society, because it creates various obstacles during the time of work and holidays especially at night. Also high level of noise is considered as a significant pollutant of the environment. Therefore, it is of practical importance to derive a mathematical expression for the calculation of noise level. In this paper are given the mathematical expressions for calculation the level of noise caused by road traffic. By the program which is created in MathCad are obtained results, tables and diagrams of the noise level when the road vehicles are travelling and the influence of various factors in noise generation and propagation.

Keywords: Noise level, vehicles, road traffic, noise pollution

1. INTRODUCTION

Traffic vehicles during their movement create noise. The noise shows a major ecological problem. Vehicles of all transport types make noise, but noise from road transport vehicles has greater impact in environment.

In urban areas, the noise created by road traffic leads to increase environmental pollution and also shows a particular ecological problem.

This noise can be caused by:

- Engines and vehicles moving mechanisms,
- Pneumatics street action, and
- Air flow from movements of vehicle.

In Fig.1, is presented chart of percentage of noise caused by different sources.

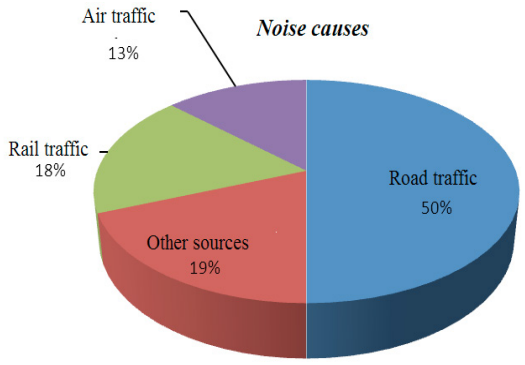

Fig . 1. Percentage of noise caused by different sources, *S. Lakušić et al (2003).*

In Kosovo, mainly are dominating the noise generated by road traffic, since rail traffic is much less developed. Noise caused by air traffic is concentrated close to the only one existing airport. From all possibilities sources of noise, noise caused by all types of traffic has the greatest participation in the total noise, somewhere around 81%, while all other resources participate with only 19%. From Fig. 1, it can be concluded that from all of sources of noise, road traffic dominates with 50%.

Different countries in Europe and wider have regulations and relevant laws applicable for the permitted noise level in urban areas. In our country the law on protection from noise, lack concrete details on limiting noise level and mathematical models for their calculation, are missing. It also noted that the law does not state with model which is used to estimate the noise created by road traffic.

European countries such as Germany, UK, Switzerland, Austria, France, the Scandinavian countries, have their own methods for calculating the noise. Countries that came from the former Yugoslavia and other European countries, each country individually determines which method to use to calculate the noise generated by the movement of road vehicles.

From the different mathematical expressions which are available in the literature for estimation of the noise level in place of its source and all the different influences up to the place of it hearing, in the paper will be presented graphically these influence and will be given conclusions with practical interest for researchers in the field of the vehicle noise.

Contributions of this work in selected topics of Conference are: *Models & Simulation* as well as *Control & Political Stability*.

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2. ANALYTICAL EXPRESSIONS FOR CALCULATING OF THE NOISE LEVEL

Different countries use expressions, which allow calculation of the noise in the emission place (creation) and the noise level in another place (place of imitation), respectively instead hearings.

Spreading of voice waves from emission place to place of imitation depends on many factors, such as:

- The distance between the place of emission and simulation,
- Configuration of the terrain,
- Absorption of air,
- Absorption of land,
- Meteorological conditions,
- Vegetation,
- Constructions area,
- The existence of barriers,
- Reflection, and
- The impact of wind and temperature.

In this paper are analyzed the factors that influence the creation and spread of the noise, mostly based on the German literature, respectively standards RLS 90 and DIN 18005 as well as various publication papers.

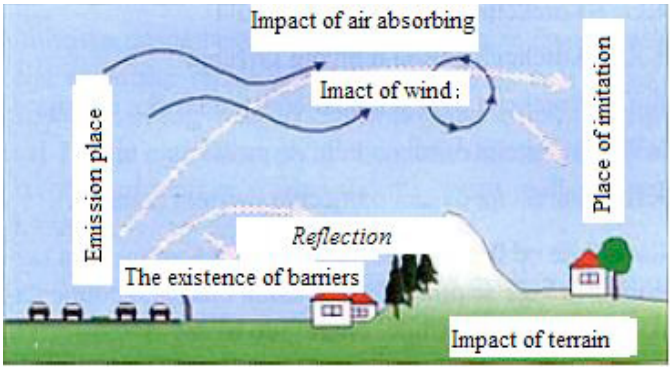

Fig. 2. Impacts in the spread of noise *S. Lakušić et al (2003)*.

To calculate noise level for 24 hours according to the recommendations of the EU norms is divided into three parts, *Standard DIN 18005, Teil 1*:

- Time of day, from 06:00 to 18:00,
- Time of evening, from 18:00 to 22:00, and
- Time of night, from 22:00 to 06:00.

The expression for estimation of the average level of the noise for general case, which is created during the day, evening and night L_{DMN}, according *Bundesanzeiger* (2006) in all three parts of the time is:

$$L_{DMN} = 10 \cdot \log\left[\frac{1}{24} \cdot \left(12 \cdot 10^{\frac{L_D}{10}} + 4 \cdot 10^{\frac{L_M+5}{10}} + 8 \cdot 10^{\frac{L_N+10}{10}}\right)\right] \text{[dB(A)]} \quad (1)$$

Where are:

L_D, L_M, L_D [dB(A)] – the average noise level generated during the time of day, evening and night.

Noise generated from road vehicles, among others also depends from road infrastructure, respectively:

- Number of road lanes,
- Number of vehicles direction,
- Branches of lanes,
- Architecture of crossroads,
- Construction of road pavement, etc.

Also traffic flow, structure, speed and technical conditions have major impact in level of noise.

2.1. Expressions for average level of noise in source place

Noise in its source, according *Bundesanzeiger (2006),* is written by the following expression:

$$L_{m,E} = L_{m25} + D_v + D_{StrO} + D_{Stg} + D_E \quad (2)$$

Where are:

L_{m25} [dB(A)] – the referent value of noise level, which created in horizontal distance from 25 [m], road construction from poured asphalt, speed of vehicles 100 [km/h], longitudinal slope ≤ 5%, which depend from flow traffic (vehicle/h) and % of vehicles over 3500 kg.

This referent value of noise level must be corrected by these additions noise level:

D_v [dB(A)] – the correction due to vehicle speed (the smallest allowed value for passenger vehicles and truck is 30 [km/h], while max allowed value for passenger vehicles is 130 [km/h], while for truck 80 [km/h],

D_{StrO},D_{Stg}, D_E [dB(A)] –the correction factor due to: type of road construction, longitudinal slope, and barriers.

2.2. Referent value of noise level (L_{m25})

Mathematical model for calculation of noise level is determined by standard DIN 18005 Teil 1, estimated by expression:

$$L_{m25}(M) = 37.3 + 10 \cdot \log\left[M \cdot (1 + 0.082 \cdot p)\right] \quad (3)$$

Where are:

M [vehicle/h] – flow traffic expressed by the total number of vehicles per hour,

p [%] – participation in % of trucks over 3500 [kg] in general number of vehicles that moves in the relevant time.

By employing expression (3), and performing calculation in MathCad software is obtained diagram shown in Fig. 3, respectively the graph *p(%)* which present referent level of noise $L_{m25}(M)$ for M = 100 up to 2000 [vehicle/h], and for eight values of participation of track p = 0%, 5%, 10%, 20%, 30%, 50%, 70%, and 100%.

Based on Fig. 3, it is notable that with increasing of traffic flow M, level of noise L_{m25} growing is digressive. Also from same figure it is seen that with growing of percent of truck p level of noise is grow. The lower curve represents the referent noise level L_{m25} for p = 0% of truck; while the upper curve represents the reference noise level per p = 100 % of truck. In practice these two extreme cases almost not find because flow traffic are combination, respectively consisting of passenger vehicles and less transportation.