RESEARCH ON MOTOR TRANSPORT PRODUCED NOISE ON GRAVEL AND ASPHALT ROADS

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Abstract. Vehicles in motion on roads are the main source of noise in the environment. The noise in a car is created by structural noises from car construction, originated from vibrations in an engine, cabin, silencer, wheels and tires. Traffic noise flow depends on its intensity, motion speed, flow composition and extent, quality of the road pavement and build-up of the area along the road. This paper contains research on motor transport produced noise levels on roads of regional significance with gravel and asphalt pavement in Molėtai district. The level of motor transport produced noise was measured in wintertime and summertime at the chosen typical locations considering the nature of the asphalt and gravel road pavement and different landscape morphology forests, topography roughness, open area, upslope, downslope, etc. Also, research of noise level dependence on car speed was performed from 50 km/h to 70 km/h. It was determined during the study that noise level produced by a car moving at a speed of 50 km/h on a road with gravel pavement is higher by 4 dBA than that on a road with asphalt pavement. Upon moving away from the noise source by 50 m, the level of noise decreases by 12 dBA in woodland open areas and by 16 dBA. As car speed increases from 40 km/h to 50 km/h in wintertime, the level of noise rises by 2 dBA. In summertime, as car speed increases from 50 km/h to 70 km/h, the noise level rises by 5 dBA. These differences are due to the presence of ice and snow on the road in winter. Noise depends on physical properties of tires, type of pavement, car vibrations and in particular on pavement roughness.

Keywords: motor transport, noise level, max noise level, reciprocal noise level, gravel road, asphalt pavement (AP).

1. Introduction

As industry develops, cities grow and the number of vehicles increases, zones of acoustic discomfort also expand increasingly. Skrodenis et al. (2009) note in their paper that people are constantly affected by noise produced by machines, equipment and devices. Motor transport is the main source of noise in cities and villages. The noise carried from streets, roads and highways forms a part of 80% of atmospheric pollution (Grubliauskas, Butkus 2009).

The acoustic pollution produced by all types of vehicles occurs as noise and vibration (Topila et al. 2000).

Nowadays, noise has become a common problem, covering all areas of people’s life and work. The harm of noise must be evaluated in pathophysiological, economical and sociological aspects and in accordance with the latest scientific achievements (Bazaras et al. 2008; Paslawski 2009; Willich et al. 2006).

Various studies confirmed the influence of noise on cardiac infarct risk at places such as work and residence (Zavadskas et al. 2007a; b).

Research works carried out in Europe showed that almost 25% of population is annoyed by noise produced by vehicles. The noisiest vehicles are trucks, buses, sports cars and motorbikes (Oškinis et al. 2004). During the research performed in the USA, it was determined that the noise level produced by heavy vehicles moving at a speed of 100 km per hour had reached a value of 87 dBA, medium vehicles – 83 dBA and light vehicles – 77 dBA.

On 25 June 2002, the European Parliament and the Council adopted Directive 2002/49/EC On Assessment and Management of Environmental Noise. This is the first document in Europe which seeks to legally regulate environmental noise (Nemaniūtė 2007).

Vehicle produced noise on roads is mostly influenced by the following factors: vehicle traffic intensity and driving speed, its change and reduction of friction between wheels and road (Baltrénas et al. 2007; Butkus et al. 2008; Vaiškūnaitė et al. 2009).

The main cause of the increased noise in streets is a high number of old and technically badly-maintained cars. During the last ten years the transport flow in Lithuania has increased 2.4 times. Because of this, a number of traffic accidents have also increased. The drivers experience longer queues and time losses at junctions (Antov et al.
2. Noise measurement technique

The nature of noise is determined prior to the measurement. Motor transport noise is variable dependent on time of the day. Noise produced by motor transport flow is constituted of the noise produced by single cars. Variable noise is noise with variation higher than 5 dBA and constantly changing, intermitting or pulsating and it is assessed by the reciprocal and max sound levels as it is indicated in the document LST ISO 1996-1:2005 Akustika. Aplinkos triukšmo aprašymas, matavimas ir įvertinimas. 1 dalis. Pagrindiniai dydžiai ir įvertinimo tvarka (Acoustics. Description, Measurement and Assessment of Environmental Noise. Part 1: Basic Quantities and Assessment Procedures (idt ISO 1996-1:2003)).

The measurement of vehicle produced noise at the chosen location was performed (by LST ISO 1996 – 2 standard) with two microphones at the same time: at point A (at a distance of 7.5 m from the axial line of the trajectory of a moving car) and point B (at a distance of 20 m); at point A (at a distance of 7.5 m from the axial line of the trajectory of a moving car) and point C (at a distance of 50 m) (Fig. 1).

The measurements of car produced noise levels were performed on roads of regional significance of Molėtai.

Fig. 1. Points selected to measure noise level produced by a moving vehicle
district. The Molėtai district was chosen due to the fact that it has both asphalt and gravel road pavement.

Typical points in consideration of pavement nature and different environmental conditions were selected (Fig. 2).

The first measurement point was an asphalt road with an arable field on one side and a meadow with thinly growing bushes on the other; an open location was selected for the measurement.

The second measurement point was a gravel road with an arable field on one side and a meadow with thinly growing bushes on the other; an open location was selected for the measurement.

The third measurement point was a gravel road with coniferous wood with thinly growing bushes starting at 10 m from the road on both sides.

The fourth measurement point was an asphalt road with coniferous wood with thinly growing bushes starting at 10 m from the road on both sides.

The fifth measurement point was selected on an asphalt road going uphill with thinly growing bushes and single trees at 15 m from the road on both sides.

The sixth measurement point was selected on a gravel road going uphill with thinly growing bushes and single trees on both sides at 15 m from the road.

Noise level dependence on light vehicle speed was measured during summertime. The station was located leeward from the road. The wind speed was 1.2 m/s, air temperature 22 °C, relative humidity of 54%. In wintertime measurements were taken also leeward. The wind speed was 1.8 m/s, air temperature 6.3 °C, relative humidity of 44%.

3. Results of transport noise measurement

Fig. 3 shows the reciprocal and max noise levels of a car driving in an open area in wintertime and summertime. Noise levels were measured while a car was driving at a speed of 50 km/h on roads with gravel and AP. As we can see from the figures, upon moving away from the driving car by 7.5 m to 50 m, the reciprocal noise levels on roads with different pavement decreased equally. The difference was 12 dBA in wintertime and 17 dBA in summertime.

As seasons change so do the sound reflections, especially when driving in wooded areas and changes also occur in coarseness of the road pavement. These changes have influence on the fact that reciprocal noise level at a distance of 7.5 m in summertime is higher by 3 dBA than in wintertime. Upon moving away the noise level is higher in wintertime. The max noise level on roads with AP upon moving away from the driving car by 7.5 m to 50 m decreases by 17 dBA in wintertime and 19 dBA in summertime. The max noise level on the road with gravel pavement decreases by 16 dBA in wintertime and 17 dBA in summertime.

On comparing the levels of reciprocal noise on roads with different pavements we see that noise level on roads with gravel pavement, when driving in an open area, is higher by 3 dBA in wintertime and summertime than it is on roads with AP. Noise caused by the tires and car vibrations is a consequence of pavement roughness.

Fig. 2. Noise level measurement points: a – network of roads of national significance of Molėtai district (the rectangle indicates the road sectors researched); b – the configuration of the roads researched (1 to 6 – measurement points)
Fig. 3. The reciprocal and the max noise levels of a car driving in an open area

Fig. 4. The reciprocal and the max noise levels of a car driving in the wooded area

Fig. 5. The reciprocal and the max noise levels spread dependence on landscape conditions

Fig. 6. The reciprocal and the max noise levels of a car driving uphill

Fig. 7. The reciprocal and the max noise levels of a car driving uphill

Fig. 8. The reciprocal and the max noise levels of a car driving uphill

Fig. 9. The reciprocal and the max noise levels of a car driving uphill

Fig. 10. The reciprocal and the max noise levels of a car driving uphill

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Fig. 59. The reciprocal and the max noise levels of a car driving uphill
Fig. 7 shows the dependence of reciprocal and max noise levels on car speed when driving on road with gravel pavement and AP in wintertime. As light vehicle speed increases from 40 km/h to 50 km/h, the level of reciprocal noise at a distance of 7.5 m from a car rises by 2 dBA. Upon moving away by 7.5 m to 50 m, the spread of the noise produced by a driving car reduces by 12 dBA.

Comparing the noise levels on roads with different pavements we see that reciprocal noise level on roads with gravel pavement is higher by 3 to 4 dBA. This difference in noise levels occurs at all distances (from 7.5 to 50 m) from a driving car.

Fig. 8 shows the dependence of reciprocal and max noise levels on car speed when driving in wooded areas on roads with asphalt and gravel pavement in wintertime. As light vehicle speed increases from 40 km/h to 50 km/h, the level of noise rises by 2 dBA. Upon moving away by 7.5 m to 50 m, the spread of a driving car produced noise on roads with AP decreases by 15 dBA and by 16 dBA on roads with gravel pavement.

A car produced noise on roads with gravel pavement in wooded areas in wintertime is higher by 3 dBA than on roads with AP.

Fig. 9 shows the dependence of reciprocal and max noise levels on car speed when driving in an open area on roads with asphalt and gravel pavement in summertime. The reciprocal noise level of a car driving at a speed of 50 km/h at a distance of 7.5 m on road with gravel pavement is higher by 3 dBA than on road with AP. When driving at a speed of 70 km/h, the difference is 2 dBA.

The difference of reciprocal noise level of a car driving in an open area at various speeds (from 7.5 to 50 m) can be seen in Fig. 10.

The results obtained show that upon increasing car speed from 50 km/h to 70 km/h, the reciprocal noise level, considering metering points, increases by 5 dBA to 7 dBA on asphalt roads and 4 dBA to 8 dBA on gravel roads.
As car speed increases from 50 km/h to 70 km/h in summertime the noise level has a tendency to rise by 2 dBA.

As car speed increases from 50 km/h to 70 km/h in summertime the noise level rises by 5 dBA.

Upon moving away from the noise source by 50 m a car produced noise in the open and wooded areas is lower by 2 dBA in summertime than it is in wintertime.

4. Conclusions

Motor transport produced noise depends on the distance from the noise source, car driving speed, territory conformation and obstacles in the way of noise spread (herbs and woody vegetation).

The noise level on roads with gravel pavement when driving in an open area in wintertime and summertime is higher by 3 dBA than on roads with AP.

The noise level in wooded areas on roads with gravel pavement is higher by 4 dBA in summertime and by 6 dBA than it is in wintertime.

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