DECREASING OF NOISE LEVEL USING RUBBERIZED ASPHALT

Vasile BACRIA, Nicolae HERIŞANU

Politehnica University of Timişoara
Bd. M.Viteazu, 1, Timişoara, Romania,
Corresponding author: bacria@mec.upt.ro

Abstract: *In the context of sustainable development and environmental protection, a special issue is represented by noise generation and propagation in the environment. An important contribution to the noise generated by the road transportation means in the environment has the noise produced by the contact between the wheel and the rolling surface. In this paper we present an investigation of the effects of rubberized asphalt on decreasing the noise produced by the contact between the wheel and the rolling surface in the road traffic. We investigated sources and the characteristics of the noise generated by the contact between the wheel and the rolling surface, the propagation ways, noxious effects and admissible limits. In order to characterize the noise we have accomplished measurements in 62 points located near some of the most important crossings from Timisoara City. The measurements were performed using the Bruel & Kjaer 2237 Controller Integrating Sound Level Meter, the N.L.-20 Sound Level Meter and the Bruel & Kjaer 2250 Hand Held Analyzer. These ones allowed identifying and recording the most important parameters of the noise. The results of measurements were processed, analyzed, interpreted and compared with the admissible values defined by standards.*

Key words**:** *noise, decreasing, rubberized asphalt*

INTRODUCTION

Every day on the streets of the towns it is developing an intense traffic. The road transportation means generate noise and vibrations which are highly detrimental for human being's life and activity. The noise generated by the road transportation means depends on the traffic intensity and composition, as well as on the speed of vehicles and it is mainly generated by three sources: the engine, the transmission system and the contact between the wheels and the rolling surface. The noise generated by the contact between wheels and the road represents around 75% from the total noise generated by the vehicle. This depends on the nature and the state of the rolling surface.

The noise generated by the contact between the tire and the road is due to the vibrations caused by the interaction between the rolling surface of the tire and the asperities of the road clothes and in the case of the smooth surfaces it is generated by the expansion of the air contained between the profiles of the tire and the road. The noise is significant at speeds which exceed 50 km/h and the most clearly manifests itself the components with the frequencies between 30 and 50 Hz.

PROPAGATION WAYS AND NOXIOUS EFFECTS OF THE NOISE

The noise generated by transportation means propagate in the environment by spherical or cylindrical waves and at long distance from the sources, even by plane waves. The noise is extremely injurious to human being's nervous system generating psycho-physiological and blood circulation modifications as well as sleep disturbances. Also the visual function and endocrine gland are adversely affected and at the same time the noise generates auditory tiredness and sonorous trauma.

In order to reduce the effects of the noise, limit values which cannot be exceeded are

established. These limits are characterized by the equivalent noise level and by the noise curves (Cz). The equivalent noise level is defined by the expression

$$L_{Aeq,T} = 10 lg \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} \frac{p_A^2(t)}{p_0^2} dt \right] \quad (1)$$

where $L_{Aeq,T}$ is the continuous equivalent level of acoustic pressure A-weighted, measured in dB, determined in a time interval which starts at t_1 and ends at t_2, p_0 is the refereed acoustic pressure (20 μPa) and $p_A(t)$ is the weighted instantaneous pressure of the acoustic signal.

The noise curves C_z define the relation between the characteristic frequency of a sound and the proper acoustic pressure level in the conditions of a subjective equivalent sensitivity.

In this respect the Romanian standard STAS 10009-88 "Urban acoustics" established the admissible limits of the noise level in urban environment, differentiated on zones and functional endorsements, technical category of streets established on the base of the technical settlements.

Table 1

Admissible limits of the noise level

Street type (according to STAS 10144-80)	L_{eq} [dB]	C_z [dB]	L_{10} [dB]
I – main	75-85	70-80	85-95
II – linking	70	65	75
III – collecting	65	60	75
IV – local serving	60	55	70

For the noise levels generated on the streets, these values are presented in table 1. In the same time the disposition of buildings on the streets of different technical types and also the road traffic organization must be made so that be assured the admissible limits for the street exterior noise level established in accordance with STAS 6161/1-79 to 50 dB measured at 2 m distance from the building, respectively the C_z45 curve.

Taking into consideration that the tire/road contact is an important source of noise in the road traffic from an urban area and the generated acoustic field is extremely complex, its study it is recommended to be experimentally performed.

MEASUREMENTS ACCOMPLISHMENT AND ANALYSIS OF RESULTS

Noise level measurements were performed in 62 measurement points which were located near some of the important crossings from Timişoara City [1], [2], [5]. The measurements were performed using the BRÜEL & KJAER 2237 Controller Integrating Sound Level Meter, the N.L.-20 Sound Level Meter and the BRÜEL & KJAER 2250 Hand Held Analyzer. These ones allowed the recording of the most important parameters of the noise, such as: L_{eq} (equivalent noise level), L_{AE} (exposure level), L_{max} (maximum noise level), L_{min} (minimum noise level), $L_{0,1}$, L_5, L_{10}, L_{50}, L_{90}, L_{95} (percentage noise levels). These parameters were determined during a continuous period of 8 hours (7.30-15.30), divided in 1 hour time intervals.

In order to perform the measurements, the microphone was placed next to the street's border at 7,5 m distance from the axis of the first runway, at 1,30 m high from the ground.

Simultaneously with noise data recording, the traffic composition and intensity as well as the speed of the vehicles were determined.

The results of the measurements as well as the intensity and composition of the traffic were centralized in a data base designed for the study of phonic pollution in Timişoara City.

From the obtained data it results that in 46 measurement points (from a total of 62 measurement points), which means 74.19% of the measurement points, the equivalent noise level exceeds the maximum admissible value defined by the Romanian standard STAS 10009-88 concerning "Urban acoustics". The overtaking was included into the interval 0,1-16,1 dB and the average equivalent noise level for the 62 measured points was 70.76 dB.

Table 2 presents the statistical distribution of the equivalent noise level (L_{eq}) in the measured points, as well as the percentage of disturbed people [7].

Table 2

Statistical distribution of the noise level

L_{eq}	No. of points	%	Percentage of disturbed people
{54,3}	1	1.6	8
[55÷60]	0	0	0
[60,3÷64,6]	6	9,7	[25÷41]
[65,2÷70]	20	32,3	[42÷60]
[70,1÷74,9]	24	38,2	[60,1÷79,9]
[75,1÷79,5]	8	12,9	[80,1÷97,9]
{81,8}	1	1,6	100
[85,5÷85,9]	2	3,2	100

Fig.1 shows a chart of the percentage of equivalent noise levels recorded in the measurement points. In these measurement points, the admissible noise level established to 50 dB(A) measured at 2 meters distance from the buildings was generally exceeded with 1,3-32,9 dB(A).

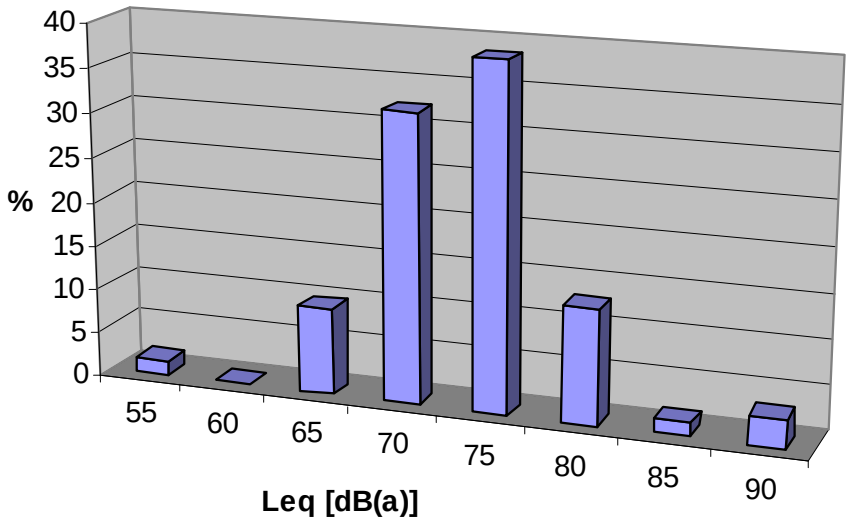

Figure 1: Percentage of noise levels in the measured points

The traffic intensity ranged during measurements between 9 and 2681 aut./h while the speed of vehicles ranged between 50 and 60 km/h. The percentage of different transportation means is presented in table 3.

Table 3

Percentage of transportation means

Transportation means	Minimum percentage %	Maximum percentage %
Buses	0,03	3,78
Trolleybuses	0,1	7,8
Microbuses	3,5	9,5
Cars	72,9	95,27
Trucks	0,3	17,9
Tractors	0,01	1,3
Motorcycles	0,06	3,0

MATERIALS AND METHODS USED TO NOISE REDUCTION

In order to reduce the noise in Timişoara City, on many streets the superstructure of the runway was improved. Many crossings were modernised and semaphores were installed. One-way traffic was imposed for some streets, the speed of vehicles was limited and on many streets were installed speed limiters. It was eliminated the presence in traffic of heavy trucks in the central area of the City. In some area it was allowed the access only for certain categories of vehicles. Some acoustic screens were installed between the runways and the residential areas and protective green zones were planted. Between the runways and the residential areas, protective green zones were planted. In the N-E of the City was activated the ring road, which re-direct the heavy traffic in this direction.

The effect of the implementation of these measures for noise reduction were evaluated through new measurements performed in 9 measurement points, selected near some of the most important crossings from Timişoara City. From the obtained data it results that in the 9 measured points, the equivalent noise level was reduced with 0,1-9,4 dB and in 5 points (55,5%) the noise level does not exceed the admissible value defined by STAS 10009-88.

In the following, we present a comparison between the situation existing in these 9 measurement points before and after the implementation of noise reduction measures.

Table 4

Statistical distribution of noise level before the application of the noise reduction methods in 9 points

L_{ech} [dB]	No. of points	%	Percentage of disturbed people
[66.2-69.7]	3	33,3	[45-59]
[70.1-74.9]	3	33,3	[60,1-79,5]
[75.6-77.1]	3	33,3	[81-88,7]

Table 5

Statistical distribution of noise level after the application of the noise reduction methods in 9 points

L_{ech} [dB]	No. of points	%	Percentage of disturbed people
[61.8-62,8]	2	22,2	[29-36]
[66.1-69.6]	4	44,4	[46-59,5]
[71.3-72.9]	3	33,4	[61-72]

Figures 2 and 3 present the chart of the equivalent noise levels percentage in those 9 measuring points before and after the implementation of noise abatement methods.

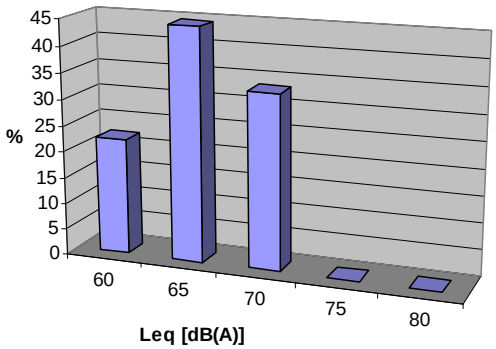

Figure 3: The percentage of the noise levels in 9 measured points after the application of noise abatement methods

From these charts it can be observed the degree of reduction of the noise level and the diminution of the percentages of disturbed people as a result of the implementation of the noise abatement methods. The average equivalent noise level in these 9 measuring points was 72,07 dB(A) for an average traffic intensity of 1595,6 aut/h before the application of noise abatement methods and 67,84 dB(A) for an average traffic intensity of 1712,8 aut/h after the implementation. As regards the average equivalent noise level existent at 2 meters distance from buildings, this one was 65,6 dB(A) before the application of the noise abatement methods and 62,7 dB after that.

The percentages of transportation means in these 9 measured points is presented in table 6 (before application of the noise abatement methods) and in table 7 (after application of the noise abatement methods).

Table 6

Percentages of transportation means in 9 measured points before the application of noise abatement methods

Transportation means	Minimum percentage	Maximum percentage
Buses	0,06	1,5
Trolleybuses	0,49	1,7
Microbuses	3,5	6,3
Cars	74,9	95,27
Trucks	0,4	17,9
Tractors	0,02	0,4
Motorcycles	0,07	1,7

Analysing these date one can say that by implementing the decreasing methods for the noise generated by the road transportation means in Timişoara City it was obtained indeed the decreasing of noise levels but the admissible limit established by STAS 10009-88 are still exceeded.

In this case other noise abatement methods are needed to be established and implemented in order to diminish further the noise generated by transportation means.

Therefore, taking account that an important contribution to the noise generated by the road transportation means on the roads has the tire/road contact, this can be reduced by

covering the road with rubberized asphalt or with rubber pavement. Using these measures it is obtained a reduction of the noise level with an average of at least 4 dB. This is used also for increasing the traffic safety through the elimination of vehicle skidding.

Table 7

Percentages of transportation means in 9 measured points after the application of noise abatement methods

Transportation means	Minimum percentage	Maximum percentage
Buses	0,1	2,5
Trolleybuses	0,5	1,6
Microbuses	3,1	16,8
Cars	66,6	93,6
Trucks	0,4	15,3
Tractors	0,1	0,3
Motorcycles	0,2	1,6

Rubberized asphalt consists of regular asphalt mixed with crumb rubber obtained from used tires that would otherwise be discarded or take up space in landfills.

Analysing the efficiency of the rubberized asphalt used on the streets from Timişoara City, one can conclude that from a total of 62 measurement points, in 26 of them (41,93%) the admissible limit is exceeded. The overtaking would be included into the interval 0,3-12,1 dB.

Table 8 presents the statistical distribution of the equivalent noise level (L_{eq}) in the 62 measurement points as well as the percentage of disturbed people after the application of the rubberized asphalt on streets.

Table 8

Statistical distribution of the noise level after the application of rubberized asphalt

L_{eq}	No. of points	%	Percentage of disturbed people
{50,3}	1	1.6	0
[56,3÷58,2]	5	8,1	[12÷23]
[60,6÷64,9]	13	21	[25,1÷43]
[65,1÷69,1]	28	45,2	[43,1÷59]
[70,0÷73,3]	11	17,7	[60÷70,1]
[75,5÷77,8]	2	3,2	[80,1÷95]
[81,5÷81,9]	2	3,2	100

Figure 4 shows a chart of the percentage of equivalent noise levels in this case.

Comparing data from tables 2 and 8, or from the corresponding charts, it can be observed the degree of reduction of the noise level and the diminution of the percentages of disturbed people as a result of the application of the rubberized asphalt on streets in Timişoara City.

CONCLUSIONS

The decreasing of noise generated by the contact between the tire and the rolling surface leads to a diminution of the degree of phonic pollution and a diminution of the percentages of disturbed people. This can be obtained by covering the rolling surface with rubberized asphalt or with rubber pavement. Using these measures it is obtained a reduction of the noise level with an average of 4 dB. Once the implemented methods prove their efficiency, these ones can be applied in every practical situation concerning traffic or industrial noise.

The alignment to European regulations imply yet the application of the Directive 2002/49/EC concerning the management of the environmental noise, this one needing, beside noise mapping, a permanent monitoring of the noise by real measurements in real conditions.

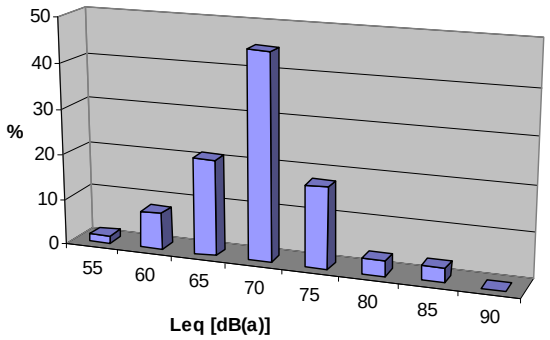

Figure 4: Percentage of noise levels in the measured points after the application of the rubberized asphalt

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