University of Nis
Faculty of Occupational Safety
„Politechnica“ University of Timisoara
Faculty of Mechanical Engineering
25th International Conference
NOISE AND VIBRATION
Tara, 27 - 29. 10. 2016.

AN EXAMPLE OF NOISE ABATEMENT MEASURES FOR RAILWAY LINE

Aleksandar Gajicki[1], *Momir Praščević*[2]

[1] PhD Student, University of Nis, Faculty of Occupational Safety, Serbia, aleksandar@gajicki.com
[1] Institute of Transportation CIP, Nemanjina 6,11000 Beograd, Serbia, gajickia@sicip.co.rs
[2] University of Nis, Faculty of Occupational Safety, Serbia, momir.prascevic@znrfak.ni.ac.rs

Abstract - *Reconstruction and modernization of railway section from Beograd Centar to Stara Pazova with total length of 34.7 kilometers, provides upgrading of existing railway line in double-track line with the designed speed up to 200 km/h. The paper discusses the current state of the environment in terms of noise, and possible impacts during construction and exploitation of the railway line. Procedure for developing a simulation model of railway traffic, noise mapping, annoyance analysis, design procedure for optimizing of noise barriers and a proposal of noise abatement measures are presented. The calculation of noise propagation, annoyance analysis and optimization of noise barriers were made using simulation modeling software package "Predictor-LimA Software Suite - Type 7810". For 477 houses which were exposed to excessive noise levels during the night according to the Serbian regulations we had planned protection measures. As a primary protection measure for 410 houses eleven noise barriers with total length of 7,070 m and surface of 24,251 m^2 are planed. Rest of the houses are protected using other measurements such as, installing soundproof windows and doors or including in noise monitoring program.*

1. INTRODUCTION

This paper deals with protection measures against the noise during reconstruction, modernization, construction and exploatation of the Beograd Centar - Stara Pazova section, which is a part of the following main railway lines: E 70 Beograd – Stara Pazova - Šid - State border - (Tovarnik) and E 85 (Beograd) – Stara Pazova – Novi Sad – Subotica - State border - (Kelebia). The Beograd Centar - Stara Pazova section is 34.7 km long in total.

Beograd Centar - Stara Pazova railway line (section) is exisisting source of noise which will change existing noise levels and disruption of the population living along the tracks after modernisation. In order to determine and minimize negative effects on the population it is necessary to calculate the future noise levels through noise mapping. Also, it is necessary to do annoyance analysis and propose abatement measures in accordance with obtained results.

In the Beograd Centar - Stara Pazova railway corridor, which is 600 m wide, has been identified 9,109 buildings, out of them 5,385 are residential and noise sensitive.

The calculation of noise propagation, annoyance analysis and optimization of noise barriers were made using simulation modeling software package "Predictor-LimA Software Suite - Type 7810".

2. PROJECT DESCRIPTION

The existing double-track line from Beograd Centar to Batajnica will continue as it is but overhaul and modernization works will be undertaken. Only passenger traffic was planned on this section; freight traffic will be possible in exceptional circumstances.

Passenger and freight traffic will be merged and split in Batajnica station within the group of tracks belonging to Belgrade Railway Junction. In addition, Batajnica will be the terminal station for urban-suburban railway traffic in the City of Belgrade.

The existing right track on the Batajnica - Nova Pazova section will be moved to ensure 4.50 m distance between tracks (with 4.00 m wide formation) planned for passenger traffic. Additional two (freight) tracks spaced at 4.00 m and 6.40 m away from the existing left track are planned after Batajnica station exit. The right freight track above double-track line for passenger traffic shall be grade-separated. After grade separation (crossing) of the right freight track over the existing two tracks, both freight tracks will run at the distance of 6.40 m from the tracks for passenger traffic.

A bed for four tracks was constructed on the Nova Pazova - Stara Pazova section; two tracks are already laid along track bed edges. The design envisages laying of two central tracks. All four tracks are designed for mixed traffic. Central tracks will be used by passenger and freight trains not planned to stop in Stara Pazova station but to run between Belgrade and Novi Sad. Peripheral tracks will be used by passenger trains planned to stop in Stara Pazova station and by trains running between Belgrade and Šid.

Planned design speeds on the Beograd Centar - Stara Pazova section:

- 100 km/h - from Beograd Centar station to Novi Beograd station and on the bridge over the Sava River,
- 120 km/h - from Novi Beograd station to Batajnica station through Bežanijska kosa tunnel;
- 200 km/h - from Batajnica station to Nova Pazova station on the tracks planned for passenger traffic;
- 120 km/h - from Batajnica station to Nova Pazova station on the tracks planned for freight traffic;

- 200 km/h - from station Nova Pazova to Stara Pazova station on the central tracks (inner two tracks), and
- 160 km/h - from station Nova Pazova to Stara Pazova station on the outer tracks.

In order to make the railway line capable for the design speeds, the following activities on subsections are proposed for modernization of Beograd Centar - Stara Pazova railway section depending on the current limitations and planned traffic organization:

I. Beograd Centar - Batajnica subsection: reconstruction of existing railway line and modernization of railway devices,
II. Batajnica – Stara Pazova subsection: construction of two new tracks, reconstruction of existing tracks and modernization of equipment and devices,
III. Beograd Centar - Stara Pazova section: reconstruction of station facilities in accordance with current and new technology tasks in the stations.

According to the design, the following stations will be retained: Beograd Centre, Novi Beograd, Zemun, Zemunsko Polje, Batajnica, Nova Pazova and Stara Pazova. The current Tošin Bunar stopping place will be relocated towards Novi Beograd stations and two new stopping places, Altina and Kamendin will be open to traffic.

UIC GC loading gauge, which enables all modes of combined transport, was adopted. Cross section was designed in compliance with the Rulebook on design, reconstruction and construction of specific elements of railway infrastructure for particular main railway lines (Official Gazette of the RS, No. 100 of 19 October 2012). Safety wire fence will be placed along the entire section.

3. CALCULATION AND NOISE MAPPING

For noise calculation and noise mapping it is necessary to use a structural approach in a problem solving. To ensure the reliable output data, it is very important to well-observe the problem, define the model and all necessary input data.

During data collection, it is necessary to carry out their analysis in terms of completeness, accuracy, consistency and compliance with the requirements of the computational model.

The process of noise calculating and noise mapping produced by rail traffic can be divided into the four main phases:

1. Input data collection and preparation,
2. Calculation of noise indicators produced by rail traffic,
3. Presentation and analysis of results, and
4. Planning of noise abatement measures which will reduce negative impacts on the environment.

3.1. Collection and preparation of input data

The input data, as well as the calculation, must be done on the basis of the chosen method`s technical instructions. Regardless of the method, it is necessary to ensure that the input data are describing the situation for the calendar year prior to the calculation. In each case the data should not be older than three years.

It is essential to provide following data: about the terrain topography, soil types in terms of sound absorption, about influence of obstacles to the propagation of sound, about the track alignment including formation width, technical characteristics of railway line, railway transport data, acoustic zones through which a new railway line passes and meteorology data.

All necessary data are obtained from Preliminary design of the Modernization of the Beograd – Subotica – State border (Kelebia) railway line, Beograd – Stara Pazova section and accompanying environmental impact assessment study [1].

3.2. Calculation of noise indicators

Noise indicators were calculated and mapped with the aid of „Predictor-LimA Software Suite - Type 7810“ software package, produced by Brüel & Kjær. The method adopted for noise calculation from railway traffic is the German method „SCHALL 03 - Richtlinie zur Berechnung der Schallimmissionen von Schienenwegen“. It complies with 2002/49/EC Directive and Ordnance on noise indicators, limits, methods for their evaluation and harmful effects in the environment (Off. Gazette RS, No.75/10) as it gives the results comparable with the recommended calculation methods.

Noise indicators were calculated in a network of points 10x10 m, 2.25 m above the ground level. Measuring points needed to determine noise level were positioned on face walls of houses and of other units 0.5 m in front of them. Noise indicators were calculated using the first degree of reflection, except at face wall measuring points where reflection from the observed building was not considered. „SCHALL 03" method allows bonus of -5 dB in the calculation of noise indicators on the railways.

Maximum height of a noise barriers is limited to 5 m on the ground and to 2 m on bridge structures.

Acoustic simulations and noise indicator calculation were done using Predictor-LimA Software Suite - Type 7810 software package and maximum dynamic error of 0.5 dB(A).

In the open air noise indicator limit values may be 65 dB(A) day and evening and 55 dB(A) night. Day means time interval 6^{00} to 18^{00}, evening 18^{00} to 22^{00} and night 22^{00} to 6^{00}.

A corridor 300 m to the left and to the right from the centre line of the Beograd Centar- Novi Beograd, Beograd - Sid - state border (Tovarnik) railway line and (Beograd) - Stara Pazova - Indjija - Subotica - state border (Kelebia) railway line, precisely the section from Beograd Centre to Stara Pazova. The same corridor was used to compare existing with prospective conditions.

Impact of noise level in the surrounding can be subdivided in two segments. The first segment includes noise due to construction of new tracks and overhaul of the existing one and the other noise from train running. These impacts overlap.

3.3. Noise during construction works

Noise level during construction of a new track and overhaul of the existing one will before all depend on the site organization, number and kinds of construction equipment, their positions and distances from houses in the impact zone. As in this design stage, organization and technology of works on site are not defined, the impact of noise in the surrounding was neither modeled nor analyzed. In any case, noisy works shall be carried out at normal work hours wherever possible, with most silenced available machines, wherever suitable and cost effective, use temporary noise suppression barriers, educate workers on site on noise issues, station most noisy machines as far as possible from houses, organize delivery and haulage of material during work hours, inform the population concerned about noisy works pending etc. During those works, periodical measurement of noise shall be performed to determine whether the generated noise level exceeds permitted limit values.

3.4. Noise from railway line in operation

A study of data on prospective railway traffic volume, new line characteristics as well as 3D terrain model noise level were calculated. Data for modelling and acoustic calculations were taken from the Preliminary design for reconstruction, modernization and construction of double track railway line Beograd - Novi Sad - Subotica - Hungarian border, the section: Beograd Centar - Stara Pazova.

Solely passenger trains will run on the section Beograd Centar - Batajnica. Further on, the line will be used for mixed traffic. Along the section from Batajnica to Nova Pazova station, tracks will be divided into passenger and freight groups while from the station of Nova Pazova on tracks will be divided by directions (from/to Novi Sad and from/to Sid).

The line is designed for maximum speed of 200 km/h. Because of constraints maximum speed from Beograd Centre to Novi Beograd will be 100 km/h, from Novi Beograd to Batajnica station 120 km/h and from the station of Batajnica further on 200 km/h.

Depending on operational technology international passenger trains to Novi Sad will run at maximum speed of 200 km/h, international passenger trains to Sid at 120 km/h maximum. Maximum speed of passenger trains in regional traffic to Novi Sad will be 160 km/h, of trains to Sid 120 km/h. Commuter trains that end their journey in Batajnica station will run at maximum speed of 100 km/h. In Novi Sad direction there will be 9 pairs of international passenger trains and 31 pairs of regional trains while in Sid direction there will be 8 pairs of international and 15 pairs of regional trains. Commuters will have 53 passenger train pairs.

Maximum permitted speed of goods trains is 100 km/h in international transport and 80 km/h in domestic transport. It was assumed in the calculation that pursuing current tendencies in international transport in Europe all goods cars shall be fitted either with disc brakes or with composite brake shoes. In domestic traffic it is assumed that every second goods car shall be fitted either with disc brakes or with composite brake shoes. In the direction to Novi Sad international cargo will be hauled with 20 pairs of trains and in domestic transport with 5 train pairs. It is assumed that average net train mass in domestic transport will be 500 tons in international transport 900 tons with the coefficient of empty wagon running of 1.4.

In the calculation of noise indicators and further analysis, solely was the noise generated by railway traffic on the Beograd Centar - Stara Pazova section considered

Example of graphic presentation of noise level at night without noise barriers is given on Figure 1.

In order to assess potential noise impact on inhabitants of prospective railway traffic on the overhauled and newly laid tracks on the Beograd Centar - Stara Pazova section, measuring points were positioned in the middle of face walls of buildings exposed to noise (persons living or working in them) that are in the corridor area. Noise indicators were calculated for days, evenings, nights, day-evening-night for a total 56,700 calculation points. The number of measurement points by number of floors is shown in Table 1.

Table 1 *Number of buildings and measurement points by floors*

Floors	Number of buildings	Number of calculation points
P+0	2.240	29.002
P+1	2.281	16.509
P+2	666	4.981
P+3	135	1.523
P+4	27	742
P+5	6	578
P+6	2	534
P+7	6	472
P+8	1	397
P+9	6	369
P+10	--	275
P+11	5	275
P+12	--	150
P+13	1	150
P+14	--	146
P+15	1	146
P+16	--	137
P+17	4	137
P+18	--	59
P+19	--	59
P+20	4	59
Total:	5.385	56.700

* P = ground floor

Acoustic zoning was not done in the project area. In order to analyse impact of noise on population and if necessary to plan protective measures it was necessary to assume, pursuant to Ordinance on noise indicators, limits, methods for their evaluation and harmful effects in the environment (Off. Gazette RS, No.75/10) that the corridor considered here belongs to zone 5 (City centre, crafts, commercial, administrative-government zone with apartments, zone along motorways, main and city avenues). Limit values for noise indicator for zone 5 during day are Lday = 65 dB(A), evening Levening = 65 dB(A) and night Lnight = 55 dB(A).

Noise indicator at night was taken as ultimate parametre for further analysis. This was based on the fact that excessive values on all measurement points occurred at night namely there were no measurement points where excessive values occurred only during day or evening.

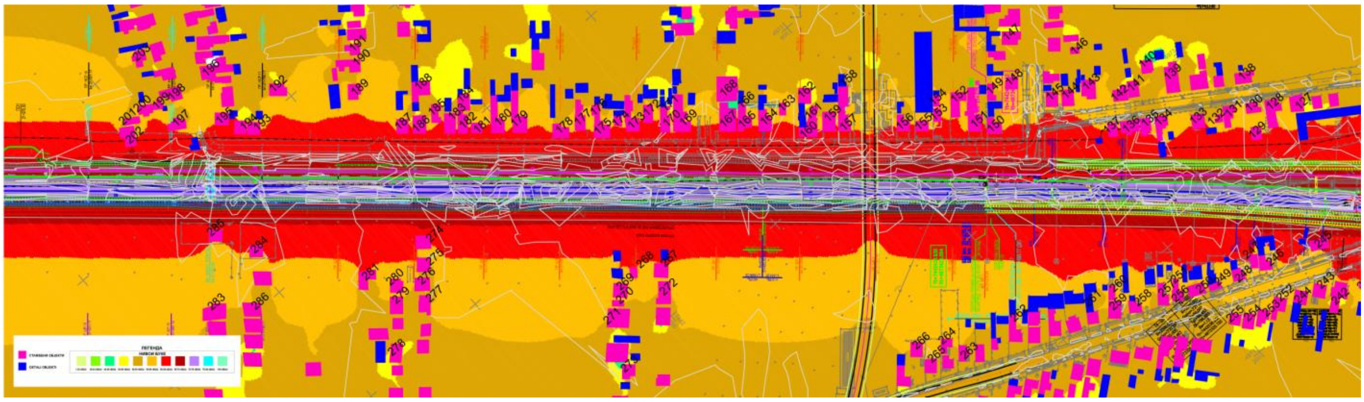

Fig. 1 *Example of graphic presentation of noise level at night without noise barriers*

It was calculated that on face walls on 477 housing units the noise level exceeded the permitted values at night (Lnight > 55 dB(A) which accounts for 8.9% of the total number of noise sensitive buildings. Excessive values were found on 1.701 face walls and/or calculation points. The number of calculation points where excessive values appeared is shown in Table 2.

Table 2 Number of measuring points with Lnight > 55 dB(A) against number of floors

Floors	Number of measurement points
P+0	855
P+1	632
P+2	159
P+3	37
P+4	3
P+5	3
P+6	6
P+7	6
Total:	1.701

* P = ground floor

3.5. Noise abatement measures

To reduce negative railway-borne noise impact on the environment and on population, measures of protection shall be planned and implemented. This shall be done wherever noise levels exceed legally permitted values.

Protection measures shall be planned and implemented only for buildings in which people live and dwell, namely buildings sensitive to noise such as kinder gardens, elementary and secondary schools, university buildings, health centres and hospitals. Attention shall be paid to working hours in those noise – sensitive buildings.

Basic noise barriers are therefore designed. In the relevant analysis and option optimisation, attention was paid not only to the existing buildings but also to planned land uses and development plans.

No noise suppression measures are planned for buildings on railway land. There are a total of 22 buildings on the railway ground for which protection measures are not planned.

They are not planned either in the spatial and urban plans for the settlements of Altina and Kamendin for 18 buildings which are located on the route of a future city avenue. The spatial and urban development plans for the Plavi Horizonti settlement include 11 buildings which are situated in the railway right-of-way in which no building construction is allowed. For this reason no protective measures are planned. Therefore, the spatial and urban plans include a total of 29 buildings for which no protective measures are planned.

The noise suppression plan does not include 51 buildings namely 10.7% of the total number of affected buildings. Noise suppression measures are planned for 426 buildings, namely 89.3% of the total number of affected buildings.

For the purpose of protection of the affected housing and other sensitive buildings, an outcome of an analysis and optimization attempt was to build 11 noise barriers, in the total length of 7,070 m and 24,251 m^2 in area. Basic details on planned noise barriers, heights of their parts, length and area are given in Table 3. Example graphic presentation of noise levels for night periods with noise barriers in place is shown on Figure 2.

Table 3 Main data about noise barriers

Barrier No.	Height	Length	Area
	[m]	[m]	[m^2]
1	2.0 - 4.0	366	863
2	2.0 - 4.0	241	772
3	2.0 - 4.0	360	1,050
4	2.0 - 3.5	280	640
5	2.0 - 4.0	400	1,080
6	2.0 - 4.0	1,344	3,858
7	2.0 - 5.0	1,204	5440
8	2.0 - 4.0	883	3112
9	3.5 - 5.0	504	2390
10	2.0 - 4.0	1,024	3,150
11	2.0 - 5.0	464	1,896
Total		**7,070**	**24,251**

Noise barriers on the ground shall be made of absorption materials while barriers on bridges shall be made of transparent materials. In order to provide better comfort to passengers, all noise barriers or at least the long ones at the level of passenger car windows should be transparent.

At "Senjak" tunnel exit towards Novi Beograd the tunnel walls should be lined with absorbing panels in the length of about 12 m, 3.5 m high as additional noise suppression measure.

All acoustic panels shall have CE marking in accordance with SRPS EN 14388 standard. In compliance with the listed standards, all acoustic panels that will be used for noise barriers shall have sound absorption of minimum 12 dB (class A4 in accordance with SRPS EN 16272-1) and soundproofing of minimum 30 dB (class B3 in accordance with SRPS EN 16272-2).

All members of noise barrier shall be grounded. The acoustic panels shall have service life of minimum 20 years without major changes in their acoustic and non-acoustic performances.

The acoustic panels and/or complete noise barrier shall be suitable for installation next to railway lines with max. permitted speeds of 200 km/h.

Noise barriers longer than 300 m shall be provided with accessible emergency door. Adequate access ways shall be provided to all emergency doors.

Standard cross sections of railway line provided with two parallel noise barrier in Figure 3.

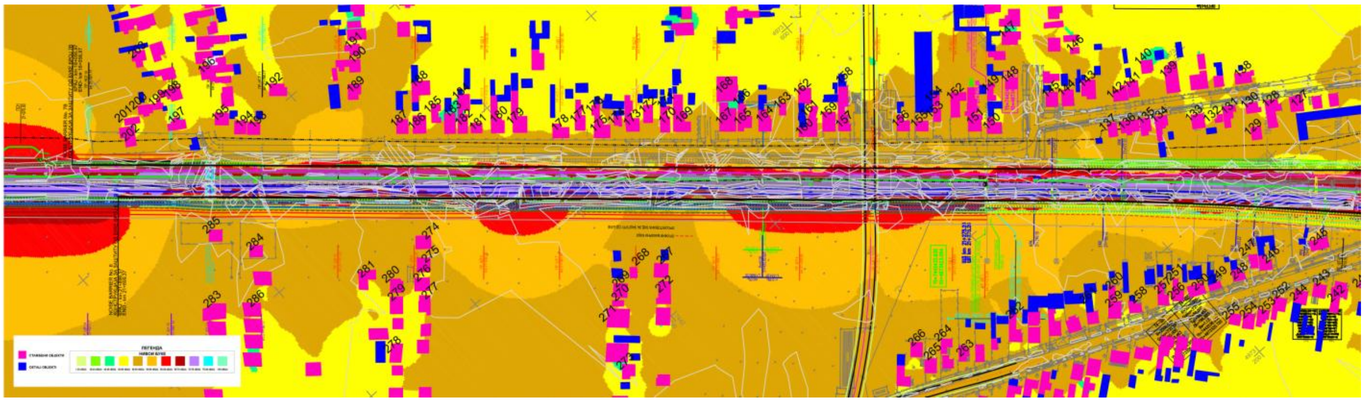

Fig. 2 *Example of graphic presentation of noise level at night with noise barriers*

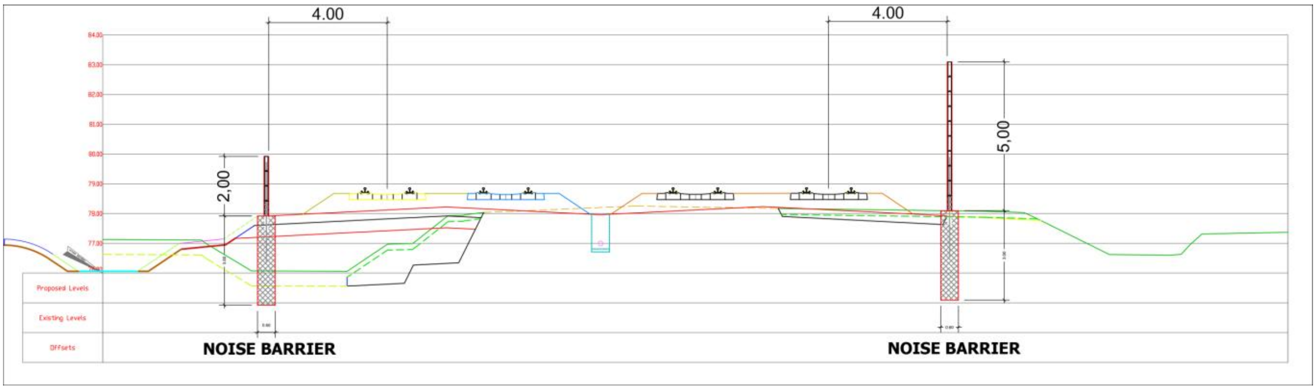

Fig. 3 Standard cross sections of railway line with noise barriers

The design of noise barriers shall comply with provisions of the Rulebook on design, reconstruction and construction of specific elements of railway infrastructure for particular main railway lines (Official Gazette of the RS, No. 100 of 19 October 2012), other relevant national and foreign legislation and positive experience of foreign and local practice.

Position of noise barriers by districts, number of buildings they protect and their efficiency are shown in Table 4.

For residential buildings and other sensitive buildings which protection by noise barriers is not economical or technically possible and for buildings where exceeding noise level occurs even after installation of noise barriers, some other protection measures were planned such as replacement of doors and windows with better sound insulated ones. Decision on the type of sound insulation (sealing glass) will be made separately for each case, with a note that small sound insulation will not resolve the above-mentioned problems while big sound insulation is not economic due to very high prices. For each building protected by replacement of doors and windows with those having better sound insulation, closed fresh air supply system should be provided as well. In addition to replacement of doors and windows on the buildings, the facades should be provided with adequate soundproofing. Disadvantage of such approach is that noise level outside the building and/or in the yards are not reduced.

Condition of tracks and rolling stock has the biggest impact on railway noise emission and therefore the regular maintenance is planned as one of the most important noise suppression measures. Planned noise barriers will fulfil their main function only if tracks and rolling stock are in good state and regularly maintained.

Table 4 *Position of noise barriers by districts, number of buildings they protect and their efficiency*

Barrier No.	District	Number of buildings they protect	Efficiency [dB]
1	Senjak (Beograd)	9	16.3
2	Senjak (Beograd)	10	16.5
3	Zemun (Beograd)	10	10.3
4	Zemun (Beograd)	4	4.8
5	Batajnica (Beograd)	22	8.4
6	Batajnica (Beograd)	83	10.6
7	Batajnica (Beograd)	94	14.8
8	Nova Pazova (Nova Pazova)	57	9.4
9	Nova Pazova (Nova Pazova)	46	11.0
10	Stara Pazova (Stara Pazova)	56	16.3
11	Stara Pazova (Stara Pazova)	19	8.5

3.6. Noise monitoring

Upon the start of the railway line exploitation, noise monitoring shall be undertaken in order to determine actual noise conditions together with periodical control measurements for further noise monitoring.

Noise monitoring during operation of the railway line operation shall serve to predict and implement adequate measures. Optimum technical measures for noise suppression can be planned only after a series of noise measurements with the railway section in operation and over a long period of time, as noise level in one moment and in one point cannot be representative of noise at that place or in a community. Besides, any optimum protective measures may be exposed to noise from other sources and may depend on the very structure of buildings in the zone of influence. Partial concepts may be counterproductive for the environment (reflection, superposition and other).

Noise monitoring shall be undertaken in zones with housing units and other sensitive buildings to be provided with noise suppression barriers. The results shall serve to confirm efficiency of erected noise barrier.

Environmental monitoring from the aspect of noise is envisaged at places where excesses are expected, before all in housing areas in the proximity of the railway line.

Points of measurement shall be representative for the project area and their number may be increased in case of justified complaints of the local population. If measurements show further excessive noise levels from the ones determined as well as some new overrun values, the Investor, namely the institution in charge shall comply.

4. CONCLUSION

Modernized and upgaded line from Beograd Centar to Stara Pazova, as old one will significantly contribute in increasing existing noise levels in areas along the railway. Noise from railway will threatened 477 residential buildings which represents 8.9% of total number.

Abatement measures are planned as follows:

- Noise barriers for protection of 410 object;
- New joinery with better sound insulation for protection of 16 objects.

No noise suppression measures are planned for buildings on railway land, for buildings where the spatial and urban plans define the route of a future city avenue and for buildings which are situated in the railway right-of-way in which no building construction is allowed. There are a total of 51 buildings for which protection measures are not planned.

The values of noise levels are given on the basis of calculation. After the railway will be put into operation it is necessary to carry out the noise monitoring. If the measured values of noise levels will exceed permitted levels, appropriate additional noise abatement measures will be applied.

ACKNOWLEDGEMENT

This research is part of the project "Development of methodology and means for noise protection from urban areas" (No. TR-037020) and "Improvement of the monitoring system and the assessment of a long-term population exposure to pollutant substances in the environment using neural networks" (No. III-43014. The authors gratefully acknowledge the financial support of the Serbian Ministry for Education, Science and Technological Development for this work

REFERENCES

[1] *Preliminary design of Modernization of the Beograd – Subotica – State border (Kelebia) railway line, Beograd – Stara Pazova section, in Beograd, New Beograd, Zemun, Zemunsko Polje, Batajnica, Nova Pazova, Stara Pazova on the building plots according to the list attached to documentation*, Saobraćajni institut CIP, Beograd, 2016 (In work).

[2] M. Praščević, A, Gajicki, D. Mihajlov, N. Živković, Lj. Živković, „*Application of the prediction model "SCHALL 03" for railway noise calculation in Serbia"*, Applied Mechanics and Materials, Vol. 430, pp 237-243, 2013.

25th INTERNATINAL CONFERENCE

NOISE AND VIBRATION

PROCEEDING OF PAPERS

Tara, October 27-29, 2016.

Publisher: *University of Niš, Faculty of Occupational Safety*
For the publisher: *Prof. Momir Praščević, Ph. D.*
dean

Editors of proceeding of papers:
Prof. Dragan Cvetković, Ph. D.
Prof. Vasile Marinca, Ph. D.
Prof. Nicolae Herisanu, Ph. D.
Prof. Momir Praščević, Ph. D.
Ass. Prof. Darko Mihajlov, Ph. D.

Graphic design and prepress:
Ass. Darko Mihajlov, Ph. D.
Rodoljub Avramović

Printout: University of Niš, Faculty of Occupational Safety
No. of copies: 150 (CD PDF)

ISBN: 978-86-6093-076-9

CIP - Каталогизација у публикацији
Народна библиотека Србије, Београд

534.83(082)(0.034.2)
62-752(082)(0.034.2)
614.872(082)(0.034.2)
628.517(082)(0.034.2)

INTERNATIONAL Conference Noise and Vibration (25 ; 2016 ; Tara)
Proceeding of Papers [Elektronski izvor] / 25th International Conference Noise and Vibration,Tara, October 27-29, 2016. ; [organizer University of Niš, Faculty of Occupational Safety of Niš, Department of Preventive Engineering [and] "Politechnica" University of Timisoara, Faculty of Mechanical Engineering, Department of Mechanical Engineering ; editors Dragan Cvetković ... et al.]. - Niš : University, Faculty of Occupational Safety, 2017 (Niš : University, Faculty of Occupational Safety). - 1 elektronski optički disk (CD-ROM) : ilustr. ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovnog ekrana. - Tekst
štampan dvostubačno. - Tiraž 150. - Bibliografija uz svaki rad.

ISBN 978-86-6093-076-9
a) Бука - Зборници b) Вибрације - Зборници
COBISS.SR-ID 229503500

ORGANIZER

University of Niš

Faculty of Occupational Safety of Niš

Department of Preventive Engineering

Noise and Vibration Laboratory

www.znrfak.ni.ac.rs

"Politechnica" University of Timisoara

Faculty of Mechanical Engineering

Department of Mechanical Engineering

Noise and Vibration Laboratory

www. http://www.mec.upt.ro

AUSPICE

Ministry of Education, Science and Technological Development Republic Serbia

www.mpn.gov.rs

GENERAL SPONSOR

Brüel & Kjær

www. bksv.com

CONFERENCE REVIEW

1st Yugoslav Conference	Belgrade	1978
2nd Yugoslav Conference	Belgrade	1979
3rd Yugoslav Conference	Belgrade	1980
4th Yugoslav Conference	Belgrade	1981
5th Yugoslav Conference	Belgrade	1982
6th Yugoslav Conference	Belgrade	1983
7th Yugoslav Conference	Belgrade	1984
8th Yugoslav Conference	Belgrade	1985
9th Yugoslav Conference	Belgrade	1986
10th Yugoslav Conference	Belgrade	1987
11th Yugoslav Conference & 1st International Conference	Belgrade	1988
12th Yugoslav Conference	Belgrade	1989
13th Yugoslav Conference	Niš	1991
14th Yugoslav Conference & 2nd International Conference	Niš	1993
15th Yugoslav Conference & 3rd International Conference	Niš	1995
16th Yugoslav Conference with international participation	Niš	1998
17th Yugoslav Conference with international participation	Niš	2000
18th Yugoslav Conference with international participation	Niš	2002
19th Conference with international participation	Niš	2004
20th Conference with international participation	Tara	2006
21st Conference with international participation	Tara	2008
22nd Conference with international participation	Niš	2010
23rd Conference and 4th International Conference	Niš	2012
24th International Conference	Niš	2014
25th International Conference	Tara	2016

PROGRAM COMMITTEE

Prof. Dragan Cvetković, Ph. D.,
University of Niš, Faculty of Occupational Safety – chairman

Prof. Vasile Marinca, Ph. D.,
"Politehnica" University of Timişoara, Romania – co-chairman

Prof. Petar Pravica, Ph. D.,
University of Belgrade, Faculty of Electrical Engineering

Prof. Giangiacomo Minak, Ph. D.,
University of Bologna, Italy

Prof. Marek Grzybowski, Ph. D.,
Gdynia Maritime University, Poland

Prof. Holger Stark, Ph. D.,
Heinrich Heine University Düsseldorf, Germany

Prof. Miloš Manić, Ph. D.,
University of Idaho, USA

Prof. Nicolae Herisanu, Ph. D.,
"Politehnica" University of Timişoara, Romania

Prof. Vasile Bacria, Ph. D.,
"Politehnica" University of Timişoara, Romania

Prof. Liviu Bereteu, Ph. D.,
"Politehnica" University of Timişoara, Romania

Prof. Gheorghe Draganescu, Ph. D.,
"Politehnica" University of Timişoara, Romania

Prof. Tihomir Trifunov, Ph. D.,
National Military University „Vassil Levski" of Veliko Turnovo, Bulgaria

Prof. Koleta Zafirova, Ph. D.,
Faculty of Technology and Metallurgy, Skopje, Macedonia

Prof. Nikola Holeček, Ph. D.,
Environmental Protection College, Velenje, Slovenia

Prof. Valentina Golubović-Bugarski, Ph. D.,
Faculty of Mechanical Engineering, Banja Luka, Rep. of Srpska

Prof. Pero Raos, Ph. D.,
Faculty of Mechanical Engineering, Slavonski brod, Croatia

Zoran Stojanović, Ph. D.,
Vinča Institute for nuclear sciences, University of Belgrade

Ratko Uzunović, Ph. D.,
VIBEX system

Prof. Ljiljana Živković , Ph. D.,
University of Niš, Faculty of Occupational Safety

Prof. Nenad Živković, Ph. D.,
University of Niš, Faculty of Occupational Safety

Prof. Predrag Kozić, Ph. D.,
University of Niš, Faculty of Mechanical Engineering

Prof. Nikola Lilić, Ph. D.,
University of Belgrade, Faculty of Minig and Geology

Prof. Slobodan Gajin, Ph. D.,
University of Novi Sad, Faculty of Civil Engineering in Subotica

Prof. Zoran Perić, Ph. D.,
University of Niš, Faculty of Electronic Engineering

Prof. Zoran Petrović, Ph. D.,
University of Kragujevac, Faculty of Civil and mechanical Engineering in Kraljevo

Prof. Zlatan Šoškić, Ph. D.,
University of Kragujevac, Faculty of Civil and mechanical Engineering in Kraljevo

Prof. Dejan Ćirić, Ph. D.,
University of Niš, Faculty of Electronic Engineering

Prof. Aleksandar Cvjetić, Ph. D.,
University of Belgrade, Faculty of Minig and Geology

ORGANISITION COMMITTEE

Prof. Momir Praščević, Ph. D.
University of Niš, Faculty of Occupational Safety – chairman

Prof. Nicolae Herisanu, Ph. D. - co-chairman
"Politehnica" University of Timişoara, Romania – co-chairman

Prof. Vasile Marinca, Ph. D.
"Politehnica" University of Timişoara, Romania

Prof. Dragica Milenković, Ph. D.
University of Niš, Faculty of Mechanical Engineering

Prof. Jasmina Radosavljević, Ph. D.
University of Niš, Faculty of Occupational

Prof. Miomir Raos, Ph. D.
University of Niš, Faculty of Occupational Safety

Ass. Branko Radičević, Ph. D.
University of Kragujevac, Faculty of Civil and mechanical Engineering in Kraljevo

Prof. Nebojša Bogojević, Ph. D.
University of Kragujevac, Faculty of Civil and mechanical Engineering in Kraljevo

Ass. Darko Mihajlov, Ph. D.
University of Niš, Faculty of Occupational Safety

CONTENT