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Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR



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MONITORING OF TRAFFIC NOISE ON URBAN ROAD INTERSECTION – CASE STUDY

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Abstract

This paper describes the assessment of noise situation at Držić and Branimir Street road intersection in city of Zagreb. This assessment includes a description of current noise situation, a comparison of current and previous noise situations, and a comment on how to reduce the noise levels and define the adequate monitoring procedure at this specific location. Considering the fact that Croatia does not have a national calculation method, noise modelling is carried out by means of German national method RLS 90, modified RLS 90 method adjusted to local conditions in Croatia, and interim NMPB-Routes-96 method recommended by Directive 2002/49/EC. Research results presented in paper can be helpful in defining monitoring procedures at other similar locations, as well as in defining unified solution applicable to wider areas.

Keywords: traffic noise, monitoring, road intersection, measurement, calculation

1 Introduction

Noise protection is one of fundamental requirements that all structures, including the transport infrastructure, must fulfil, [1]. Studies conducted in EU countries have shown that in urban areas road traffic noise represents a serious environmental problem, and that about 20 % of its inhabitants are exposed to noise levels higher than 65 dB(A), [2]. Scientists and health professionals claim that such noise levels are unacceptable because they disturb people, and have a negative impact on their health, [3-4]. Special attention should be devoted to areas in vicinity of urban road intersections, where traffic conditions are very specific due to various sections with different traffic flow conditions (constant speed, stop and go, deceleration and acceleration), [5-6].

In order to timely perform all necessary activities related to noise protection continuous monitoring should be carried out, [7]. Noise monitoring should include noise mapping and field measurements, [8]. Experience has shown that the optimal method of noise mapping is the use of calculation models calibrated by limited number of field measurements. If noise levels are higher than those prescribed by regulations, noise protection measures should be applied, and another assessment of new noise situation should be made. Therefore, the choice of optimal monitoring procedure, including the methods, quantity and periods of noise measurements, should be prescribed within the framework of an integrated structure management program, [9].

2 Location description

Držić and Branimir Street road intersection is urban intersection located in Zagreb narrower city centre, near the main bus and train station. This intersection has four approaches, and each of them contains splitter islands and several entering and exiting lanes. Road traffic flows in all directions, while tram traffic does not flow in the directions east-south and south-east (Figure 1). Traffic is regulated by traffic lights. In the vicinity of the observed area there are residential and business facilities. Residential ones are mainly four-storey buildings up to 12 m high, while business buildings are of the same height or lower.



Figure 1 Držić and Branimir Street road intersection, [10]

3 Noise analysis

Noise analysis at Držić and Branimir Street road intersection included traffic volume measurements, noise modelling by means of specialised noise prediction software LimA, and validation of applied calculation models by noise measurements.

3.1 Traffic volume measurements

Short term traffic volume measurements were carried out by means of video camera, in day period from 7:30 a.m. to 8:30 a.m. (Figure 2). Recorded vehicles were divided in three main groups: personal cars, heavy vehicles and trams (Table 1). As it can be seen most of these vehicles were passing in directions north-south and south-north.

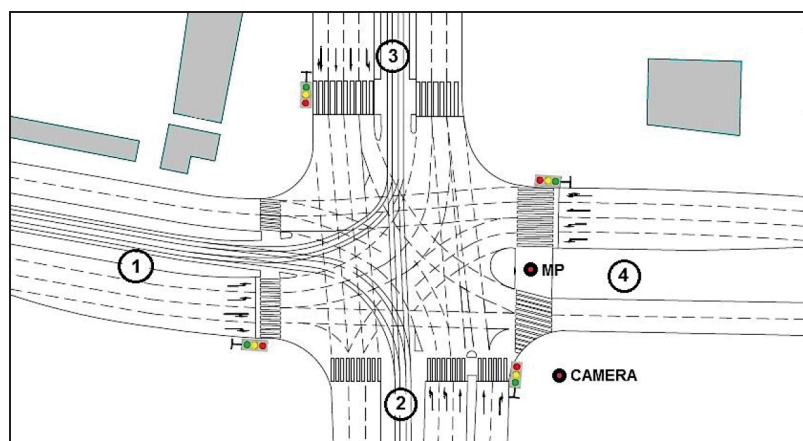


Figure 2 Noise analysis at Držić and Branimir Street road intersection

Table 1 Traffic volume measuring results at peak hour (7:30 a.m. to 8:30 a.m.)

Direction	Number of vehicles		
	Personal cars	Heavy vehicles	Trams
1 – 2	360	30	21
1 – 3	213	8	0
1 – 4	404	11	-
2 – 1	381	18	22
2 – 3	1061	44	16
2 – 4	174	7	-
3 – 1	188	10	0
3 – 2	1368	40	15
3 – 4	261	3	-
4 – 1	375	17	-
4 – 2	288	8	-
4 – 3	66	6	-

3.2 Noise modelling

Noise modelling was carried out by means of German national method RLS 90, modified RLS 90 method adjusted to local conditions in Croatia, and interim NMPB-Routes-96 method recommended by Directive 2002/49/EC, [11]. German national method RLS 90 was modified due to the following reasons.

Placing the noise source above all traffic lanes and measuring the actual vehicle speed is more responsive to real traffic situation than assuming that all vehicles are traveling in outer traffic lanes, at speed limited by traffic signs. In addition to above, AADT algorithm in RLS 90 method contains certain parameters which are applicable only in Germany i.e. they are not in accordance with traffic conditions in other countries. Main differences between the applied methods are given in Table 2. It can be seen that only interim NMPB-Routes-96 method observes vehicle dynamics and contains separate class urban road.

Table 2 Main differences between the applied methods

Parameters	Method		
	RLS 90	modified RLS 90	NMPB-Routes-96
Noise source	0,5 m above outer traffic lanes (Figure 3a)	0,5 m above all traffic lanes (Figure 3b)	0,5 m above all traffic lanes (Figure 3b)
Traffic volume	AADT + trams, % of heavy vehicles	determined by field measurements	cars/h heavy vehicles/h
Speed	defined by traffic signs	determined by field measurements	average car speed average heavy vehicle speed
Class urban road	-	-	+
Acceleration / deceleration			

The digital terrain model was approximated by a horizontal plane due to intersection small longitudinal slopes and general flatness of the terrain. The height of surrounding facilities was 3 m per floor. It was assumed that travelling speed of personal cars amounts 50 km/h, and of heavy vehicles and trams 40 km/h. These speed values were considered when vehicles were driving straight through the intersection. In case of left and right turns, speed was reduced.

Calculations were conducted at one free field receptor FF_01, placed 1.2 m above the splitter island at intersection east approach (Figure 3, Table 3), and at grid points defined by Croatian regulations (grid 10x10 m at the height of 4 m) (Figure 4), [12].

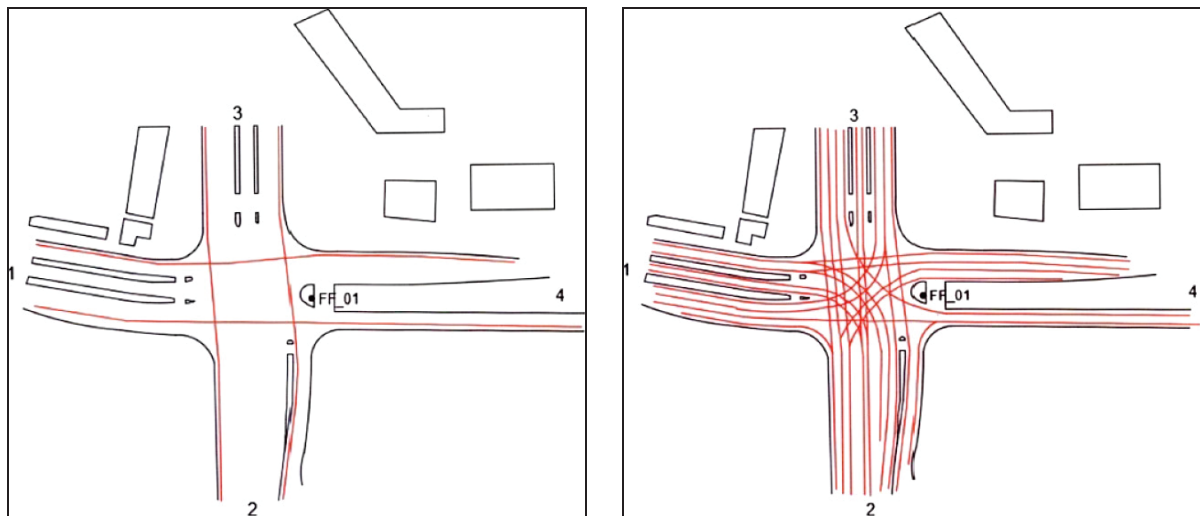


Figure 3 Noise sources and free field receptor for RLS 90 model (left) and modified RLS 90 and NMPB-Routes-96 models (right)

Table 3 Noise calculation results at free field receptor FF_01

Receptor	Noise levels [dB(A)]		
	RLS 90	modified RLS 90	NMPB-Routes-96
FF_01	74.4	73.4	75.0

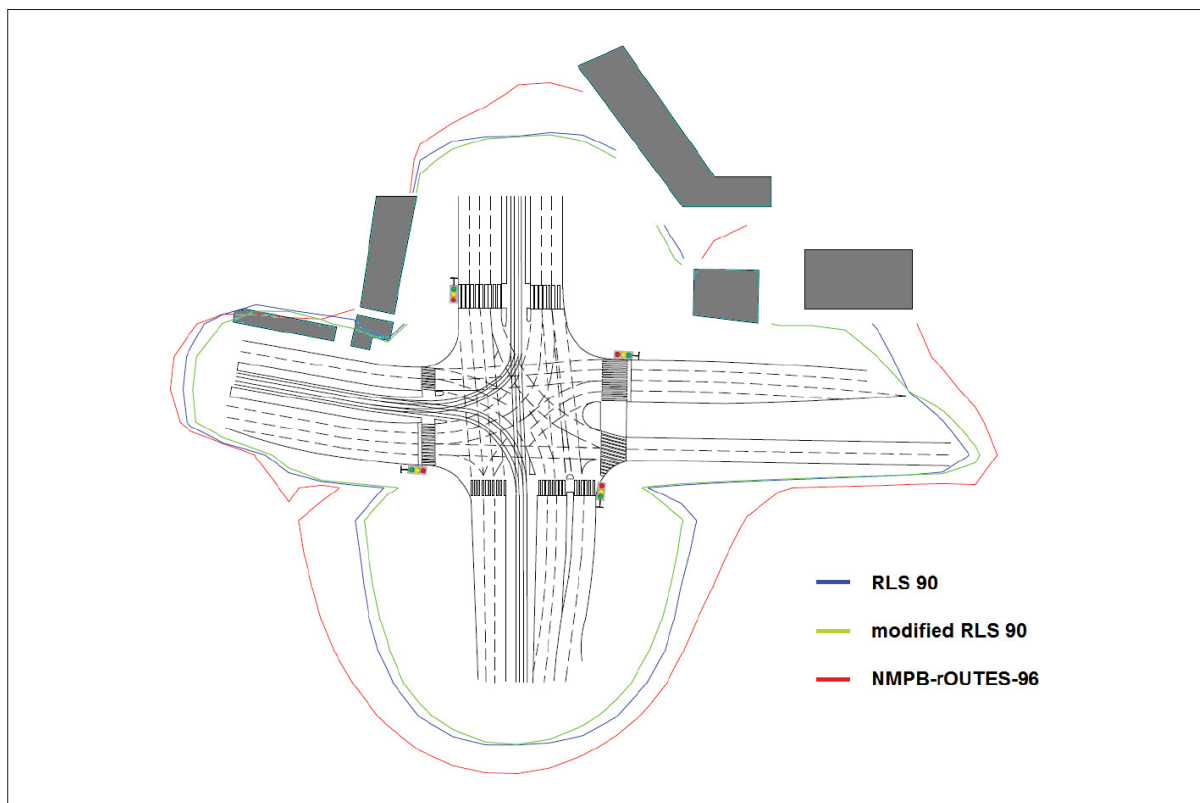


Figure 4 Comparison of 65 dB(A) noise contours for day period

3.3 Noise measurements

Noise measurements were conducted by means of sound level meter Brüel & Kjaer type 2260, simultaneously with traffic volume measurements. Measuring point MP was placed at the same place where free field receptor FF_01 was located in noise modelling procedure (Figures 2 and 4). Measurements were carried out under favourable meteorological conditions. Air temperature was 18 °C, wind speed 0.3 m/s, air pressure 1011.8 hPA, and humidity 60 %. Noise measuring results have shown that noise level at measuring point MP amounted 72.5 dB(A).

4 Comparison of current and previous noise situations

Previous noise analyses at this specific location were conducted in year 2005. Noise measurements were carried out at the same measuring point and in the same time period, while the noise modelling was conducted only by means of modified German method RLS 90. The reasons for this are as follows. German method RLS 90 was widely used in Croatian engineering practise because Croatia does not have a national calculation method. In order to adjust this German method to local conditions in Croatia, certain modifications have been introduced (Table 2).

In year 2002, European Commission realised the Annex II of Directive 2002/49/EC, which recommends the use of interim NMPB-Routes-96 modelling method in all Member States that have no national computation methods until the harmonized method is devised, [13]. In the time period from 2002 to 2005 Croatian engineers had not entirely adopted this interim method and they continued to use modified RLS 90 method. In year 2007, the use of interim NMPB-Routes-96 method in noise mapping in Croatia has become mandatory, [14]. Additional objective of this study was to evaluate the reliability of application of this French calculation method in noise monitoring procedures in Croatia. Comparison of current and previous noise situations at measuring point MP i.e. free field receptor FF_01 is given in Figure 5. As it can be seen, in the time period from 2005 to 2017 noise levels have not changed i.e. surrounding facilities are still exposed to noise levels higher than those prescribed by regulations.

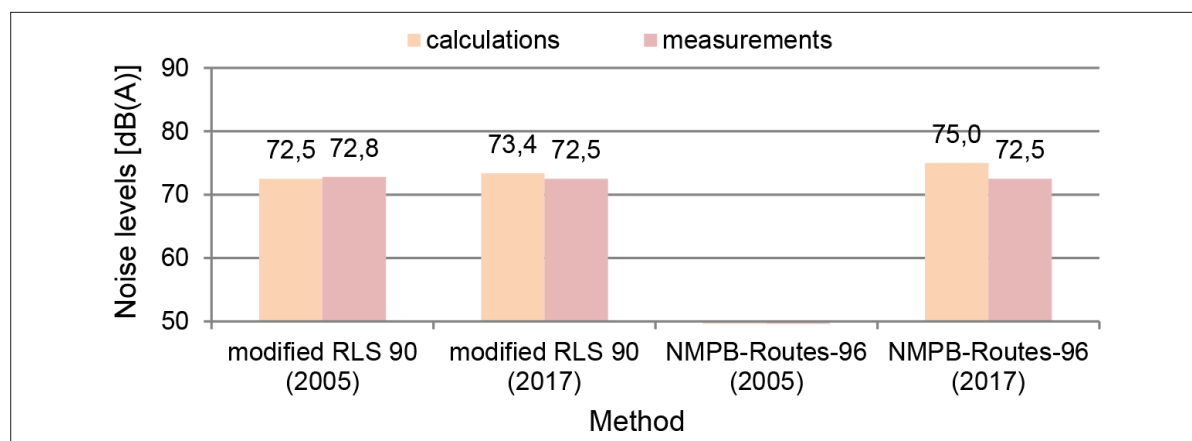


Figure 5 Comparison of noise calculation and noise measuring results

5 Conclusions

It is indisputable that continuous noise monitoring should be carried out, in order to ensure sufficient life quality and health of the residents. Consequently, monitoring time periods and methods should be prescribed, and application of adequate noise protection measures should be considered. In this research, urban road intersection was chosen for the analysis, since at such sites the most demanding traffic operations take place. Noise monitoring at this

specific location should be carried out at least ones in five years. Modified German method RLS 90 was more reliable, despite the fact that interim NMPB-Routes-96 method takes into account a greater number of influential parameters which describe the complexity of relations in urban environment. This modified German method considers the actual traffic volume and real driving speeds. Even though the use of this interim method is mandatory in Croatia, the application other method which is more convenient for use at observed area should be considered. In the light of the above considerations, it can be concluded that monitoring procedure recommended in this paper can be used in the assessment of noise protection measures in urban areas such as: redirection of traffic at other roads in the city, free traffic flow during night periods, education of residents about causes of increase of noise levels, increasing the price of parking tickets in narrower city area, introducing fees for vehicles that produce noise higher than prescribed, and grater incentives for the purchase of hybrid and electric cars. Application of noise protection barriers, known for their good absorption properties, is not acceptable in urban areas due to spatial constrains. The choice of above noise protection measures is in domain of city authorities, which have a complete overview of all processes in the city. Possible solutions are conditioned by coordination with solutions from other resors. A problem of high noise levels in urban areas can be solved only by long-term planning, good cooperation between citizens and authorities, and implementation of adequate protection measures and continuous monitoring.

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