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THE INTERSECTIONS GEOMETRY INFLUENCE OVER THE ROAD TRAFFIC NOISE POLLUTION

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***Abstract*—** The city of Brasov is in constant transformation since 2007. Several intersections have been structurally modified. Also in 2009 the city beltway was put into use and the traffic composition was changed. This paper aims to analyze the level of noise pollution according to the geometrical parameters of intersections. This study is a comparison between the values of the road traffic noise registered for one intersection, in three different periods. Analyzing the registered values can be said that the main contributor to noise pollution was not the geometrical parameters (transforming the traffic lights intersection into a roundabout). However, the main contributor to noise pollution is the traffic composition. Transforming the traffic lights intersections in roundabouts has little effect over the noise pollution in urban areas.

***Keywords*—** Noise, Pollution, Intersection geometry, Vehicle, Roundabout.

I. INTRODUCTION

ALONG a stretch of road, the most critical places are considered to be road intersections. Usually, traffic engineers will design a road intersection based on the anticipated volume of traffic that will use the intersection. Severe traffic congestion can occur as a result of designing road intersections according to inappropriate standards. Increase in congestion will certainly increase the amount of pollutants being emitted. Along an arterial road, the critical place is the road intersection. Usually, the capacity of the road intersection will determine the capacity of the arterial road. If the capacity of the road intersection is high, then the traffic carrying capacity of the arterial is also high [1]. There are several factors that affect the capacity of intersections that need to be taken into consideration during design, i.e. intersection type, lane width, number of lanes at each approach. There are three major types of road intersection, priority intersection, roundabout, and signalized intersection. The capacity of traffic light intersections is higher than the capacity of priority and roundabout intersections. Thus, signalized intersection should be provided whenever high traffic volume is anticipated. Intersections with more and wider lanes usually have greater capacity, and thus reduce the occurrences of traffic congestion. Uphill approaches to intersections, particularly when in combination with high numbers of heavy vehicles, will usually increase congestion [1], [2].

Roundabouts should be considered at a wide range of intersection types including but not limited to freeway terminal interchanges, state route intersections and local route intersections. Roundabouts perform better at intersections with roughly similar traffic volumes and at intersections with heavy left turning movements [1].

Fig. 1. Normal roundabout from Brasov City.

Fig. 2. Compact roundabout from Brasov City.

The types of roundabouts are: normal roundabouts, compact roundabouts, mini-roundabouts, grade separated roundabouts, signalized roundabouts, double roundabouts. Normal roundabouts: A normal roundabout has a kerbed central island at least 4 meters in diameter. Its approaches may be dual or single carriageway roads. Compact roundabouts: A compact roundabout has single lane entries and exits on each arm. The width of the circulatory carriageway is such that it is not possible for two cars to pass one another [1] [3].

II. Features of the Analyzed Intersection

Noise pollution in Brasov County is on one hand generated by the fact that Brasov represents a central point of Romania's transport system with oncoming and going heavy traffic; and on the other hand the noise is generated by stationary sources and diverse production processes of goods and materials. A major influence of the urban area pollution in today's Brasov, is the geographical layout of the city. Starting as a medieval town, Brasov was strategically positioned between mountains. It was surrounded by Tampa Mountain at S and S-E, and by the foot of the Postavaru Mountain at S-V, V and N-V, having the 1799m high Postavaru Peak not further from 10 km away [4].

The Gării Avenue with Harmanului Street and Alexandru Vlahuta Steet Intersection is one of the city's intersections with the most abundant traffic flow.

Fig. 3. Gării Avenue, Harmanului Street and Alexandru Vlahuta Steet Intersection.

Therefore, the trolleybus line, numerous bus lines, taxi cabs, public transportation with short, medium and long route busses and minivans, supply trucks and minivans, and last but not least private vehicles, they are all passing trough this very intersection in a very weigh number. The traffic speed limit for the each of the arteries of this intersection is 50 km/h. Prevailing vehicle type that transit the intersection: compression ignition engine vehicles and spark ignition engine vehicles; the public transportation vehicles with articulated and unarticulated buses and articulated trolleybuses; traffic intensity at rush hour: very high [4].

III. The Noise and Traffic Flows Measurements

Environmental noise caused by road traffic is assessed for different purposes: to assess the acceptability of new building developments in noisy areas; to determine the nature and amount of noise abatement provisions, in case of excess of the limit value; to assess the acceptability of a new infrastructure in the neighborhood of residential areas; to assess the necessity of remedial action in the case of excessive noise in residential areas [5].

For noise measurements was used Sound Level Meter - Type 2250 from Bruel&Kjaêr. This sound meter has been developed specifically for measuring occupational, environmental and product noise, while complying fully with all the relevant national and international standards.

The tasks for environmental noise measurements are varied, so the instrument you pick for your measurements needs to be flexible, easy to configure, powerful and accurate. 2250 Light is all that, and more, making it ideal for a simple noise enforcement measurement one moment, then a complex environmental impact survey the next. 2250 Light is built on the core platform of the award winning design of Type 2250. It borrows the robust construction, intuitive touch screen interface, and legendary Bruel&Kjaêr measurement accuracy [6].

For each of the nine analyzed intersections were centralize the noise average values over the period of measurements, recorded for one hour interval (15.00 – 16.00).

For intersection's analysis there were collected data about the road traffic and data about the noise pollution in the neighborhood of the road. The most common and handy method is the manual collecting of the road traffic data, with the help of an observer team, each member of this team writing down a specific element of the road traffic [6].

TABLE I
Traffic Composition Studied Intersection Registered in 3 Different Years

Year	Light vehicle	Unarticulated bus	Articulated bus	Trolley bus	Heavy vehicle	Trams
2007	3420	45	23	33	389	20
2010	3870	80	41	15	82	0
2012	3875	107	46	17	65	0

For a certain input with variable time signals it is established the following data measurement in order to analyze the intersection: traffic volume, number of vehicles which are passing the stop line, for each traffic direction (forward, left, right), for each vehicle category [7]. The volume of the traffic flow was determined by

counting the total number of the vehicles, which passed through the intersection during one hour (15.00-16.00) in all ways.

The noise pollution measurements ware made in similar weather conditions for 2007, 2010 and 2012.

IV. INTERSECTION ANALYZES IN FUNCTION OF GEOMETRICAL PARAMETERS AND TRAFFIC FLOW COMPOSITION

In the studied intersection in 2007, 2010 and 2012, noise measurements were made. The measuring points and hour interval were the same, with little positioning changes imposed by the geometrical parameters. In the year of 2008 occurred the first modification of the intersection, by removing the trams from the city. In 2011 the intersection was transformed from a traffic light intersection in roundabout. Also, at the end of 2009 the Brasov bypass road was finalized and the heavy traffic was completely removed from the city. In these conditions we chose to compare noise pollution measurements made in 2007, 2010 and 2012. The difference between the 2007 and 2010 configurations of the intersection is mainly given by the road infrastructure (changing the geometric parameters of the intersection). Analyzing the 2010 and 2012 configurations of the intersection it can be noticed that the main change is the road traffic flow (significant decrease of the heavy vehicles number). The Fig. 4, 5 and 6 present the intersection schemes in the years 2007, 2010 and 2012 which shows the changes of geometrical parameters from 2007 to present.

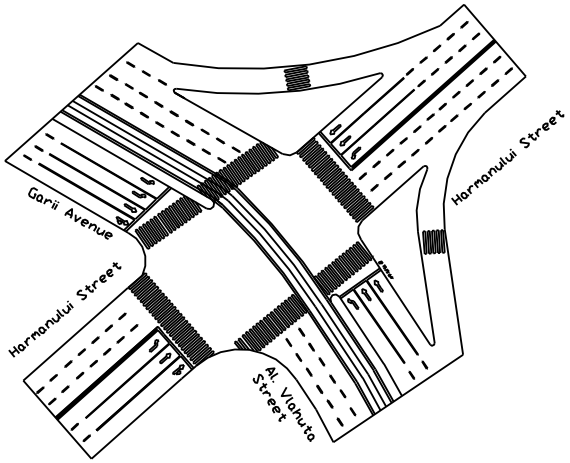

Fig. 4. Intersection layout in 2007.

Also, in Fig. 6 are presented the points where measurements were made. In this 12 points were made noise pollution measurements with Sound Level Meter - Type 2250 from Bruel&Kjaêr.

The number and the poison of measurement points was chosen regarding to the intersection geometrical parameters, traffic flows and placement of the main institutions or socio-cultural destinations.

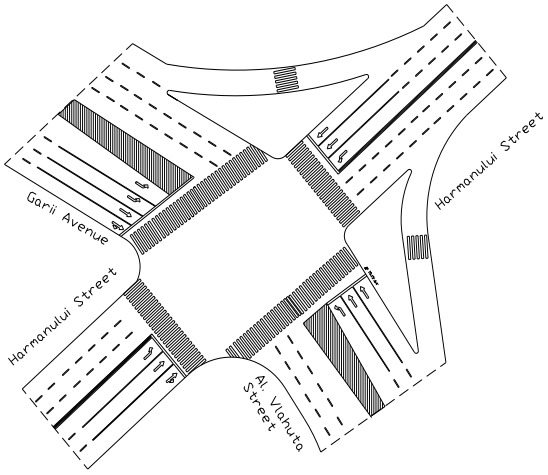

Fig. 5. Intersection layout in 2008.

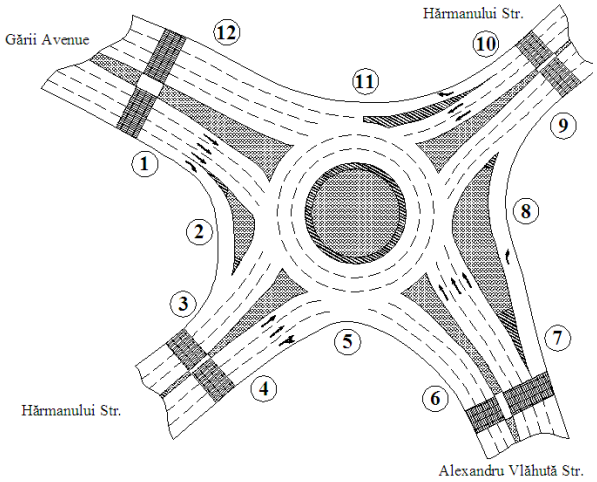

Fig. 6. Intersection layout in 2012 and the noise measurement points.

To make a comparison between the values recorded from all three measurements, the values collected were centralized.

TABLE II
TRAFFIC COMPOSITION FOR STUDIED INTERSECTION REGISTERED IN 3 DIFFERENT YEARS

Year	2007		2010		2012	
Point	MaxL (dB)	Leq (dB)	MaxL (dB)	Leq (dB)	MaxL (dB)	Leq (dB)
1	83,5	75,1	79,2	74,1	80,7	73,6
2	83,9	74,5	75,6	72,5	74,4	72,2
3	76,2	73,6	74,7	71,9	75,2	72,5
4	78,1	72,1	73,6	68,7	75,2	71,7
5	72,8	63,6	70,7	63,2	76,7	63,7
6	77,8	74,1	81,4	75,5	77,1	71,2
7	83,4	75,5	78,4	72,1	80,9	73,2
8	85,8	76,6	81,5	74,7	77,5	70,3
9	84,2	75,9	80,4	72,1	75,8	72,9
10	81,8	74,3	81,4	73,5	78,8	72,3
11	85,9	75,3	81,8	72,4	76,4	69,3
12	85,6	74,1	80,2	70,1	79,2	71,6

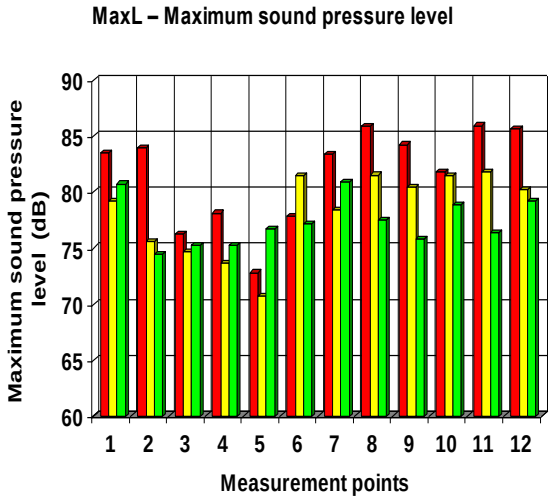

Fig. 7. Maximum sound pressure level for 2007 (red column values), 2010 (yellow column values) and 2012 (green column values).

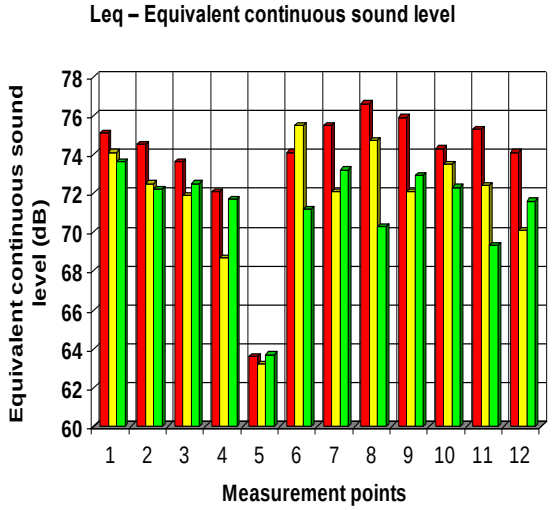

Fig. 8. Equivalent continuous sound level for 2007 (red column values), 2010 (yellow column values) and 2012 (green column values).

The parameters from Table II have the following meanings:

- Leq – Equivalent continuous sound level over the elapsed measurement time;

- MaxL – Maximum sound pressure level over the elapsed measurement time [6].

Analyzing the registered values can be said that the main contributor to the noise pollution is the traffic composition. It is essential that the heavy vehicles number present in the traffic flow to be minimized. Transforming the intersection from the traffic lights intersection in roundabouts has little effect on the noise pollution in urban areas. If for a traffic light intersection, the main noise level suffers variations between measurement points, for a roundabout the noise values are a little lower and there is uniformity throughout the entire area.

V. Conclusion

In this study the geometric characteristics in terms of intersection layout, number of movements and position of the intersection were observed. Traffic characteristics such as traffic composition and turning volumes were also observed during the evening peak hour. The noise levels registered at the traffic light intersection layout were compared with the noise levels registered for the roundabout intersection layout. In case of the original signalized intersection there is only one stop, when entering in the intersection (red color of the traffic light), then a portion with acceleration, weighted by the vehicles flow (since there are many vehicles starting together) In this points the noise level is higher than other areas of intersection.

In case of roundabout, there are two or more stops, because beside the stop when entering in roundabout there are also two pedestrian crossings, before and after the roundabout. Exiting the roundabout is accelerated, and since the distance to the vehicle in front is higher than when starting in an intersection signalized with traffic lights, the acceleration may be higher.

An important conclusion resulted from this comparative analysis is the significant increase of acceleration in case of roundabout. Regarding the noise pollution, the acceleration influences the level in a higher measure than the speed.

The final conclusion is that the geometry of the intersection has a much smaller influence than traffic composition regarding the noise pollution in urban areas.

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