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ANALYSIS OF TRAFFIC CONDITIONS AT THE BRZEZINSKA AND NOWOCHRZANOWSKA INTERSECTION IN MYSLOWICE (SILESIAN PROVINCE, POLAND)

Summary. A detailed analysis of traffic conditions at the intersection allows us to obtain information about the efficiency of its operation. This type of analysis usually involves assessing the capacity and scale of the intersection and applying classical measures to assess its quality. In Poland, for this purpose, methods developed by the General Directorate for National Roads and Motorways are used to estimate the capacity of intersections without traffic lights, intersections with traffic lights, and roundabouts. The paper presents the results of the analysis of traffic conditions at the intersection of Brzezinska and Nowochrzanowska Streets, located in Myslowice (Silesian Province, Poland). The paper also examines the findings on traffic safety at this intersection.

Keywords: traffic conditions, intersection capacity road traffic engineering

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1. INTRODUCTION

One of the basic tasks within traffic engineering is the efficient organization and management of traffic in dense transport networks. The implementation of these tasks in today's world is difficult due to the presence of these dense transport networks on the one hand, and significant traffic volumes on the other hand. Hence, the search for effective ways to efficiently organize and manage traffic in these networks requires the involvement of newer and more efficient tools. In the literature on this subject, there are numerous studies devoted to numerous aspects of these kinds of problems, as well as other relevant problems of a technical nature [1-10,12,13].

A detailed analysis of traffic conditions at the intersection allows us to obtain information about the performance of the intersection. This information is necessary, both for the design and for the modernization of intersections. This type of analysis usually involves estimating the capacity and scale of intersections and applying classical measures to assess the quality of their operation. Depending on the location and the country in which the analysed intersection is located in the capacity calculation, adequate methods are used. In Poland, methods were developed in 2004 by the General Directorate for National Roads and Motorways. These methods allow for the estimation of crossing capacity without traffic lights, intersections with traffic lights, and roundabouts. The paper presents the results of the analysis of traffic conditions at the three-lane intersection at Brzezinska and Nowochrzanowska Streets, located in Myslowice (Silesian Province, Poland).

Myslowice is located 15 km east of Katowice. According to statistics [11], the city covers an area of 66.00 km^2 and is inhabited by 74,851 people; thus, the population density is 1,141 people/km^2 (condition on 2015 r.). The intersection is located in the southern part of the city in the Brzezinka district and operates on the principle of traffic regulation with the use of road signs. The main street with priority of passage is Brzezinska Street, while entry onto Nowochorzowska Street is subordinated. Based on repeated traffic observations, it was found that the intersection did not function smoothly, as evidenced by the high level of vehicle queues, which formed during traffic rush hours, and the significant amount of time spent by drivers waiting in those queues in order to enter onto the main road. At this crossroads, a large amount of traffic is recorded, mainly due to the fact that the intersection is located in the industrial area of the city. In addition, Brzezinska Street, which is the main road, leads to and from the centre of Myslowice and Katowice. In turn, Nowochrzanowska Street leads traffic to and from the centre of Jaworzno. In the course of further analysis, the following entry designations were adopted:

- Brzezinska Street (south entry) – Entry A
- Brzezinska Street (north entry) – Entry B
- Nowochrzanowska Street (east entry) – Entry C

2. CHARACTERISTICS OF THE BRZEZINSKA AND NOWOCHORZOWSKA INTERSECTION

Before measuring the traffic, information on the geometry of the intersection was collected. At Entries A and B, the lane widths are the same, i.e., 3.50 m. At Entry C, the carriageway is narrower, with the width of each lane being 3.25 m. The geometry of the intersection is shown in Figure 1a.

In terms of traffic organization, the traffic at the intersection is regulated by road signs. At Entries A and B, there are D-1 signs, which inform drivers of the road ahead. At Entry C, there is a B-20 sign directing drivers to enter the intersection after stopping before the road with priority of passage. A diagram of the traffic organization at the intersection is shown in Figure 1b.

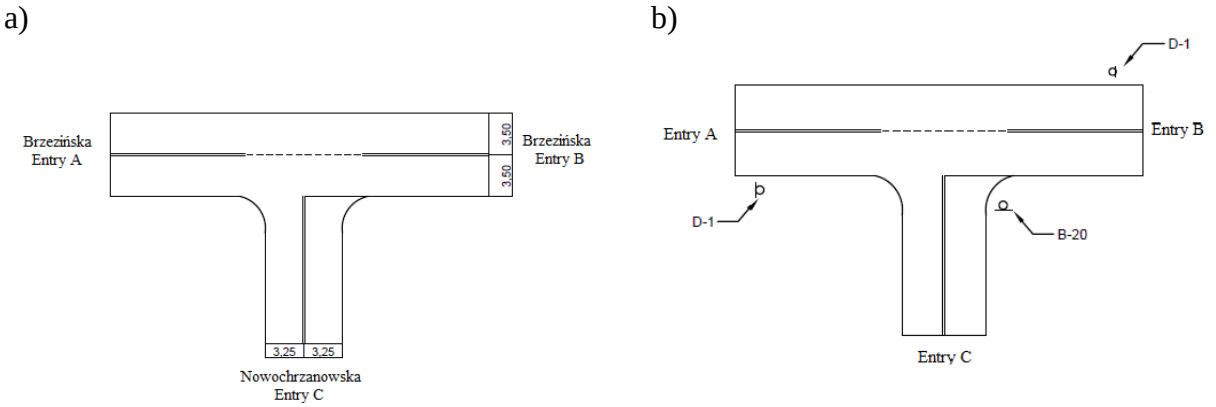

Fig. 1. Intersection of Brzezinska and Nowochrzanowska Streets in Myslowice (Silesian Province, Poland): a) diagram of the geometry of the intersection, b) scheme of traffic control

The crossroads are characterized by a significant number of public transport lines. Over the course of the day, you can see an increase in the amount of short and articulated buses. The nearest bus stop is about 100 m from the intersection, while its location has no significant impact on traffic conditions at the intersection because of the limited number of courses on Nowochrzanowska Street (once an hour). There is not too much traffic in the traffic, and there is a crossing for several public facilities in the area. Pedestrian crossings are within a few dozen metres of the intersection. The nearest crossing is at Entry C, which is about 24 m from the road with priority for the crossing.

A large and notorious recurring problem at the intersection is the service of left- and right-turning vehicles. The problem is particularly evident in traffic rush hours when the waiting time for entering from Entry C is potentially much longer than at the other entries. By anticipating a continuous and systematic increase in the number of vehicles on the road network, it can be said that this problem will intensify.

3. TRAFFIC MEASUREMENT AT THE INTERSECTION

Traffic intensity measurements were needed to collect the necessary data to perform calculations, which would allow us to analyse the capacity of the intersection and evaluate the traffic conditions. Several hours of traffic measurements were made at the intersection. Measurements were made using the manual method (writing on forms) in 15 min intervals, with reference to the following generic structure of passing vehicles: passenger cars and vans (SOD), buses (A), lorries (SC), articulated buses (AP), lorries with trailers (SCP), motorcycles and bikes (M/R). Measurements were made under favourable weather conditions, i.e., without precipitation in sunny weather. In addition, the measurements were smooth.

The results of the traffic measurements illustrate the structure type of the vehicles, as well as the distribution of traffic in 15 min intervals. It should be noted that, at the analysed intersection, passenger cars and vans were more commonly observed than other vehicle types. Buses and articulated buses were most commonly found at Entry A, while the largest number of trucks was recorded at Entry C. Motorcyclist and cyclist traffic was limited. Pedestrian traffic was also limited and did not affect the functioning of the junction in question. The rush hour was between 16:00 and 17:00. Traffic during rush hour was at the level of 1,365 vehicles/h. The results of traffic measurements on Entries A, B and C are presented in Tables 1-3. These data provided the basis for the calculation of crossing capacity.

Tab. 1

Summary of traffic measurement results for Entry A

Relation	Traffic in straight relation [vehicles/h]						Traffic in relation to right [vehicles/h]					
Measurement intervals [min]	SOD	A	AP	SC	SCP	M/R	SOD	A	AP	SC	SCP	M/R
16.00-16.15	100	2	0	0	2	0	28	0	0	1	0	1
16.15-16.30	103	2	0	1	1	0	29	0	0	0	0	0
16.30-16.45	102	1	1	0	0	2	28	0	0	1	1	0
16.45-17.00	99	0	2	1	0	0	30	0	0	1	0	1
Total	404	5	3	2	3	2	115	0	0	3	1	2

Tab. 2

Summary of traffic measurement results for Entry B

Relation	Traffic in straight relation [vehicles/h]						Traffic in relation to left [vehicles/h]					
Measurement intervals [min]	SOD	A	AP	SC	SCP	M/R	SOD	A	AP	SC	SCP	M/R
16.00-16.15	111	1	1	0	0	1	28	0	0	1	0	1
16.15-16.30	116	1	1	1	1	1	28	0	0	2	1	0
16.30-16.45	115	0	1	2	0	0	27	0	0	0	1	0
16.45-17.00	109	1	1	0	0	2	25	1	0	1	0	1
Total	451	3	4	3	1	4	108	1	0	4	2	2

Tab. 3

Summary of traffic measurement results for Entry C

Relation	Traffic in relation to left [vehicles/h]						Traffic in relation to right [vehicles/h]					
Measurement intervals [min]	SOD	A	AP	SC	SCP	M/R	SOD	A	AP	SC	SCP	M/R
16.00-16.15	18	0	0	2	1	0	29	0	0	1	0	0
16.15-16.30	19	0	0	1	1	0	28	1	0	0	0	1
16.30-16.45	17	0	0	0	3	0	28	0	0	1	2	0
16.45-17.00	19	0	0	1	0	0	26	0	0	2	0	0
Total	73	0	0	4	5	0	111	1	0	4	2	1

4. CAPACITY OF INTERSECTION IN EXISTING STATE

The highest value for actual capacity is given with regard to Entry A, i.e., 1,729 vehicles/h. In turn, the lowest actual capacity was obtained for Entry C, i.e., 197 vehicles/h. Apart from the capacity values, the quality of the intersection was also determined. The average loss of time across the intersection was 21.49 s/vehicle. The levels of traffic freedom and the length of reliable queues were determined for all entries. At Entry C, the longest queue consisted of nine vehicles.

5. ANALYSIS OF ROAD TRAFFIC SAFETY AT THE INTERSECTION

On the basis of the data on the number and types of traffic incidents at the analysed intersection, a comparative characterization of the calculated coefficients was made. For the analysed intersection, data covering the period from 1 January 2006 to 31 October 2017 were obtained. The structure of traffic incidents is shown below.

In the given period, 27 road events. At the intersection, only one accident occurred in this period, in which only one person was injured. No fatalities were recorded for any traffic incident. The remainder involved road collisions, in which neither injuries nor fatalities were registered. In the analysed period, the following types of vehicles took part in road incidents: SO (passenger cars), M (motorcycles), SC (lorries), SCP (lorries with trailers), A (buses) and I (others, e.g., bikes, low-speed vehicles). There were no traffic incidents involving light trucks (LSC) and agricultural tractors (CR). The accident that led to one person being injured person concerned a passenger car and a lorry without a trailer. Most road accidents occurred between passenger cars. Most probably, these were on account of forcing the right of way through the intersection. Figure 2 presents a summary of the number of traffic incidents in the analysed period. The largest number of road accidents was in 2007.

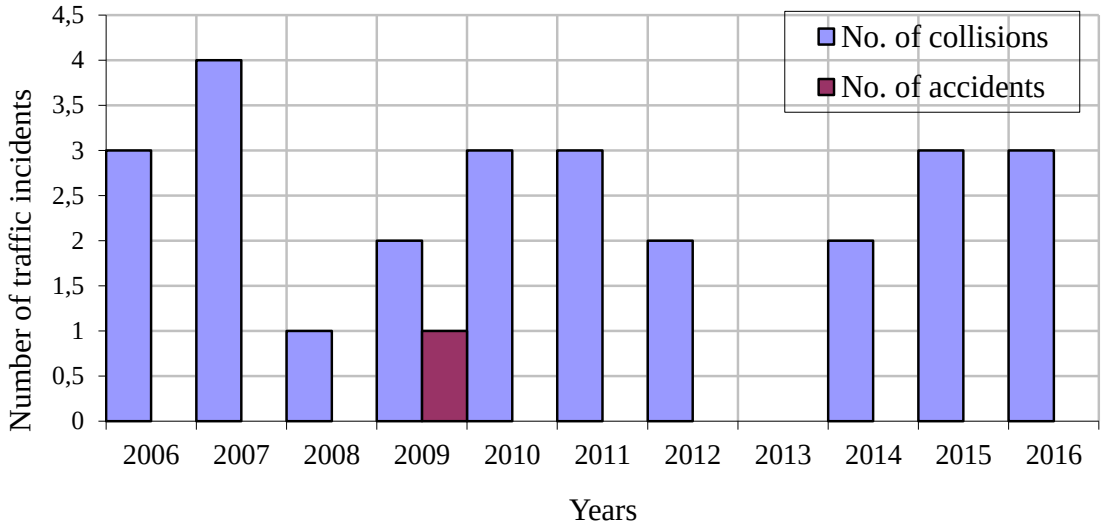

Fig. 2. Number of traffic incidents on crossroads in Myslowice (Silesian Province, Poland)

The characteristics of the generic structure of vehicles participating in road incidents at the analysed intersection are diversified. Figure 3 shows the given characteristics. It should be noted that the majority of vehicles are passenger cars.

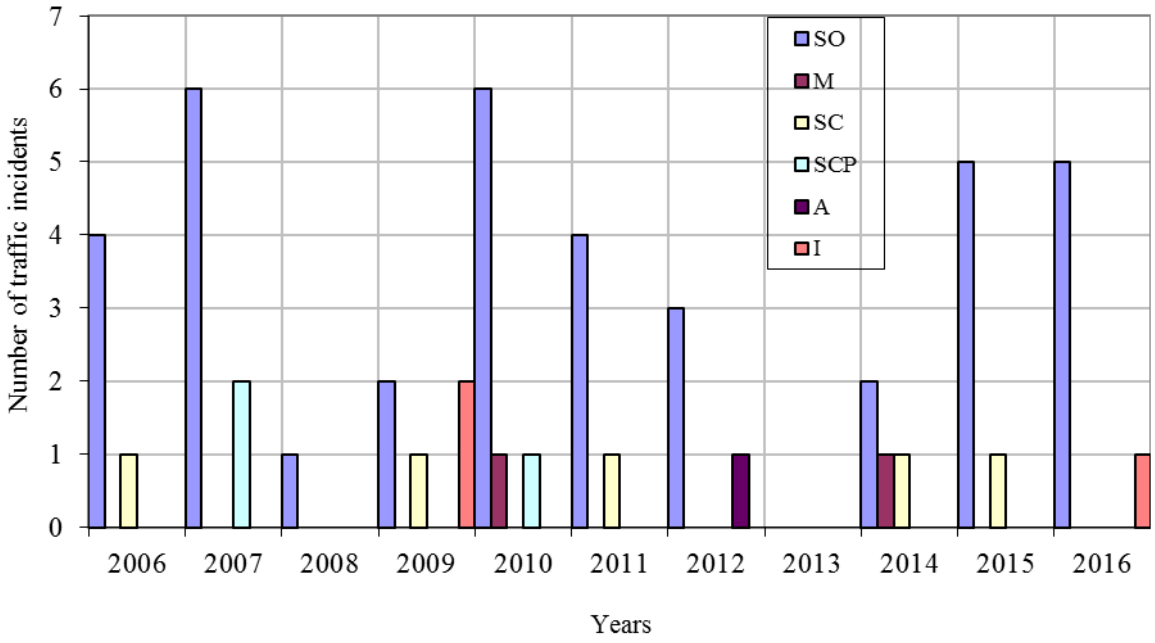

Fig. 3. Generic structure of vehicles involved in traffic incidents at crossroads in Myslowice (Silesian Province, Poland)

Road traffic incidents were analysed in terms of the months of occurrence. The road accident described earlier took place in September 2009. Figure 4 shows the number of road incidents divided into months for the analysed period.

6. CONCLUSIONS

The main objective of the presented analysis was to evaluate traffic conditions at the intersection of Brzezinska and Nowochrzanowska Streets, located in Myslowice (Silesian Province, Poland). The determined values of the functional quality of the intersection allows us to state that the greatest values for time losses were incurred by drivers at Entry C, i.e., 128.71 s/vehicle. In turn, the smallest time losses were incurred by drivers at Entry A, i.e., 1.23 s/vehicle. This confirms that Entry A is the most efficient in functional terms. The characteristics of traffic conditions at the entries allows us to state that, for Entries A and B, the level of traffic freedom is PSR I, while, for Entry C, it is PSR IV, which indicates that drivers of vehicles passing through this entry cannot effectively cross the examined intersection. We also estimated the lengths of reliable vehicle queues for each entry. The longest car queue formed at Entry C and consisted of nine vehicles, while the shortest formed at Entry A and consisted of two vehicles. During the analysis of road safety at the intersection, it was noted that:

- The largest group of vehicles involved in road incidents comprised passenger cars (38 vehicles throughout the analysis period)
- Vehicles from the LSC or CR group were not involved in road incidents
- The most traffic incidents occurred in 2007 (four traffic incidents) and the least in 2013 (zero traffic incidents)
- The most traffic incidents occurred in September (five traffic incidents) and the least occurred in January (zero traffic incidents)

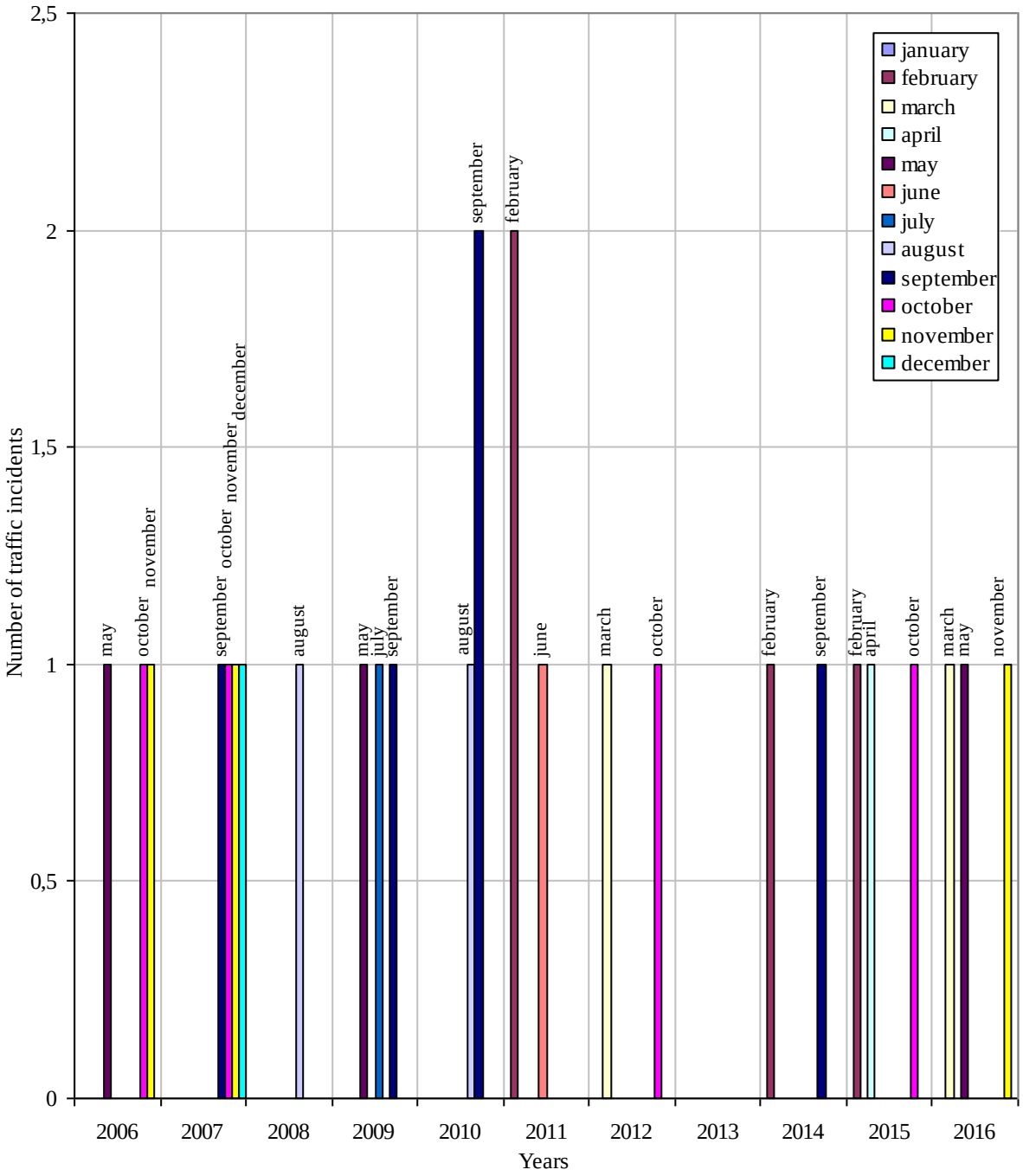

Fig. 4. Number of traffic incidents in certain months at crossroads in Myslowice (Silesian Province, Poland)

The analysis and assessment of traffic conditions at the intersection of Brzezinska and Nowochrzanowska Streets in Myslowice could inform the decision to change the traffic organization at the intersection, e.g., by constructing an additional lane at Entry C or installing traffic lights. Such a change could improve the traffic conditions at Entry C, where unsatisfactory traffic conditions were observed for drivers. However, such a decision requires further detailed analysis in this regard.

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