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ANALYSIS OF AVERAGE DELAYS OF ROUNDABOUT VINKOVAČKA - DRINSKA IN OSIJEK

ANALIZA SREDNIH VREMENSKIH GUBITAKA U KRUŽNOM RASKRIŽJU VINKOVAČKA - DRINSKA U OSIJEKU

ABSTRACT

The intersection traffic analysis involved the assessment of capacity and adaptability of the observed traffic solution to the needs of different types of traffic and users. Indicators analyzed in the qualitative assessment are: capacity reserve, degree of saturation, delays and queue length at the intersection. Delays are an indicator that directly affects traffic users, considerably more than engineering-oriented capacity or capacity reserve. The same indicator was used to evaluate the level of service of the intersection. The microsimulation models are very useful tool for the analysis and prediction of traffic conditions on existing and planned intersections. However, it is questionable whether they can be expected to give realistic modeling results that can be applied in the methodology of analysis and design of roundabouts in local conditions. The VISSIM microsimulation traffic model used for traffic simulation and the traffic indicator which had been selected to analysis was the indicator of a delay. The best insight into the applicability of a VISSIM microsimulation traffic model on roundabouts in local traffic conditions is provided by the comparison of modelled and measured data. The process of model calibration and validation implements the comparison with values of traffic parameters measured in real traffic conditions. The selected traffic indicators for the calibration and validation procedure were travel time and queue. The analyses third traffic indicator of average delay at the observed roundabout was chosen to serve as an efficiency measure of the calibration. Measured delay was compared with modeled delay for the same traffic stream with calibrated and default values of input model parameters. Results of analysis and comparison measured and modeled data of average delays are given in this paper.

***Key words**: roundabout, microsimulation, delay, level of service*

SAŽETAK

Analiza funkcionalnih prometnih karakteristika raskrižja uključuje ocjenu propusne moći i sposobnost prilagodbe promatranog prometnog rješenja potrebama različitih vrsta prometnih korisnika. Pokazatelji koji se analiziraju u okviru kvalitativne ocjene raskrižja su: rezerva propusne moći, stupanj zasićenja, vremenski gubitci i dužina kolone vozila. Vremenski gubitci su pokazatelj koji ima direktan utjecaj na prometne korisnike, znatno više od inženjerski

orijentirane propusne moći ili rezerve propusne moći. Vremenski gubitci se koriste i za ocjenu razine uslužnosti raskrižja.
Mikrosimulacijski prometni modeli su vrlo koristan alat za analizu i predikciju prometnih uvjeta na postojećim i planiranim raskrižjima. Ono što je upitno, može li se očekivati da će model dati realne rezultate modeliranja, tako da se može primijeniti u metodologiji analize i projektiranja kružnih raskrižja u lokalnim uvjetima.
VISSIM mikrosimulacijski prometni model odabran je za potrebe prometnih simulacija, a srednji vremenski gubitci su odabrani prometni pokazatelj za analizu. Najbolji uvid u primjenjivost VISSIM mikrosimulacijskog prometnog modela na kružna raskrižja u lokalnoj sredini dobije se usporedbom modeliranih i izmjerenih podataka. Postupak kalibracije i validacije modela u lokalnim uvjetima implementira usporedbu sa vrijednostima prometnih pokazatelja koji su izmjereni u stvarnim prometnim uvjetima. Za postupak kalibracije i validacije modela odabrani su prometni pokazatelji vrijeme putovanja i dužina kolone vozila. Analiza trećeg prometnog pokazatelja, a to su srednji vremenski gubitci u promatranom kružnom raskrižju, napravljena je da bi poslužila kao mjera efikasnosti postupka kalibracije. Izmjereni vremenski gubitci uspoređeni su sa modeliranim vremenskim gubitcima za promatranu prometnu struju u raskrižju, sa kalibriranim i nekalibriranim (default) vrijednostima ulaznih parametara modela. U ovom radu su prikazani rezultati analize i usporedbe izmjerenih i modeliranih srednjih vremenskih gubitaka u kružnom raskrižju Vinkovačka-Drinska u Osijeku.

***Ključne riječi**: kružno raskrižje, mikrosimulacije, vremenski gubitci, razina uslužnosti*

1. Introduction

Nowadays, justifiability and efficiency analysis and evaluation of economic, environmental and other influences of construction of new structures and introduction of new technologies into the traffic system are done by computer simulation modelling. Success of modelling of urban traffic network and its segments is in the service of successful modelling of critical elements of the network. According to a large number of criteria, the critical points of a traffic system are the intersections. Intersections are places of large traffic concentration and distribution which are filling and emptying traffic routes. Delays at intersection take 17%-35% of the overall travelling time [8]. Researches [4] made on a large population of school children show that approximately 75% of traffic accidents which include children occur on intersections. In an urban traffic network of a primary functional level, two types of intersections prevail – the ones with traffic lights and roundabouts. Experiences in application of microsimulation models on intersections with traffic lights are numerous and positive. Modelling of roundabouts with simulation tools has its distinctions which may cause larger deviations between modelled and measured data [10]. This paper supports the evaluation of microsimulation tools applicability to roundabouts, and as an experimental basis a chosen roundabout in the traffic network of the city of Osijek has been used.

2. Functional characteristics of intersections

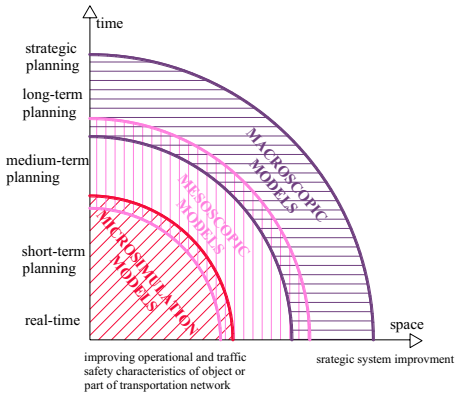
Indicators analyzed in the qualitative assessment of an intersection are: capacity, capacity reserve, degree of saturation, delays (which affect level of service) and queue length at the intersection. Intersection capacity (C) is defined [3] as the maximum number of vehicles that can pass the intersection (the measured section of each traffic route) at a given time period and in defined traffic, weather and other conditions. Capacity reserve (R) is the difference between intersection capacity and its actual traffic volume and is expressed by the number of vehicles. Degree of saturation (A) is defined by the ratio of actual traffic volume and

intersection capacity and is expressed in percentages. Delays are defined as the total waiting time of vehicles at the intersection due to traffic and weather conditions, traffic regulation, intersection geometry, sight distance at the intersection, deceleration and acceleration of vehicles, and other factors. Queue length is the number of vehicles in a queue on access roads in the intersection zone. Level of service indicates the degree of traffic quality. Levels of service according to a criterion of average delays are given in the references [2, 5,11].

3. Microsimulation traffic models

The application of various simulation models needs to be considered within the temporal and spatial scope. Specific simulation models are developed for certain types of traffic analysis and are intended for decision makings which differ in temporal and spatial coordinates (Figure 1). Microsimulation models are able to model the stochastic nature of traffic flow at the multi-modal level: car - truck – bus/tram - a cyclist- pedestrian, through a detailed movement modeling of each entity.

Figure 1 Temporal and spatial scope of simulation models



Source: author

3.1. VISSIM microsimulation model

VISSIM is a stochastic, discrete, micro-simulated model designed for traffic analyses. It started to develop in Germany at the University of Karlshruhe in the early 70-ies of the last century. For the longitudinal vehicle movement (car-following movement) the model implements the sub-model of psycho-physical modeling of car following behavior (Wiedemann psycho-physical submodel), and for lateral movement (lane changing) there is the sub-model based on the defined rules of acceptable time gap for changing lanes in vehicle moving [6].

4. Application of the VISSIM for modelling the observed roundabout

Model calibration is, according to the Highway Capacity Manual (2000), the process of comparing model parameters with actual data obtained by counting and measuring at a local network [9]. The aim is to reduce the discrepancy between output results of a simulation model and data obtained by measurements and observations in the field. Model validation is evaluation of calibration model efficiency by comparing modeled and measured traffic parameters.VISSIM microsimulation model is calibrated for local traffic conditions in the network of the city of Osijek by application of neural networks. Validation of the calibrated model on one-lane roundabouts in Osijek has shown a good match between measured and

modelled data for examined traffic parameters – time of travel and length of a queue of vehicles at the entrance into the intersection [5]. Analysis of a third parameter, like delays, which has not been considered in the process of calibration, will provide a new insight into the success of the calibration process.

4.1. Roundabout Vinkovačka-Drinska

Vinkovačka-Drinska intersection is one-lane roundabout with a primary functional level. Outside radius is 30m, and the width of one-lane entrances into the intersection ranges from 2.75 to 3.5m (Figure 2). Before the reconstruction, done in 2005, the examined Vinkovačka-Drinska intersection used to be a classic four lane intersection. The basic reason for the reconstruction was the fact that there were large delays on the side rout from the direction of Drinska Street. The critical traffic streams were left turns from Drinska to Vinkovačka Street, average delays were longer than 50 seconds per vehicle which implied the lowest (F) level of service [5].

Figure 2 Roundabout Vinkovačka- Drinska

Source: author

4.2. Analysis of delays of the roundabout

Total delay is a total amount of time which vehicles loose at an intersection. Geometric delay, specific for roundabouts, is caused by intersection geometry. Pure geometric delay is delay of an isolated vehicle which is safe from being obstructed by a vehicle from conflicting traffic flow. It is theoretical and such delays are not measurable in normal traffic conditions. The difference between total delay and geometric delay, which is also called control delay, is conditioned by traffic volume of the main traffic flow and traffic regulation. Increased total delay will lead to the decreased impact of geometric delay.

4.2.1. Measured delays

Measuring of input parameters for the model (volume and distribution of the traffic volume) and traffic indicators, like time of travel and delays, at the examined intersection, has been done on March 3rd 2010 in the afternoon traffic peak hour between the 3 and 4pm. For the purpose of assessment of geometric delays inside the intersection, numerous measurements of time of travel in daytime and night-time conditions and with a small traffic volume in the intersection were made. The shortest time of driving between measuring points in the real traffic conditions was 13 seconds.

4.2.2. Comparison between measured and modelled delays

From the comparison between the traffic flow from Drinska Street into the roundabout measured at the site and the number of vehicles in simulated traffic flows, it is obvious that the VISSIM model does not generate the same number of vehicles as the one counted at the

field and entered into the model, but it rather sticks to the given traffic distribution (Table 1). In order to make it comparable, the traffic volume is conditionally homogenized by introduction of equivalent units of personal vehicle (PCE). There is a more detailed explanation in the references [1,11].

Table 1 Traffic volume of observed traffic stream - measured vs. modelled

	TRAFFIC VOLUME (PCE/h)	
TRAFFIC STREAM	MEASURED	MODELLED
LEFT:Drinska-Vinkovačka south	139	152

Source: author

Delays for the measured section (which consists of the traffic stream of the left turn from Drinska to Vinkovačka Street – South) are measured and compared to the modelled delays for the same stream with calibrated and non-calibrated (default) values of model input parameters. Comparison between measured and modelled delays is shown in the Table 2.

Table 2 Comparison of modelled and measured delays

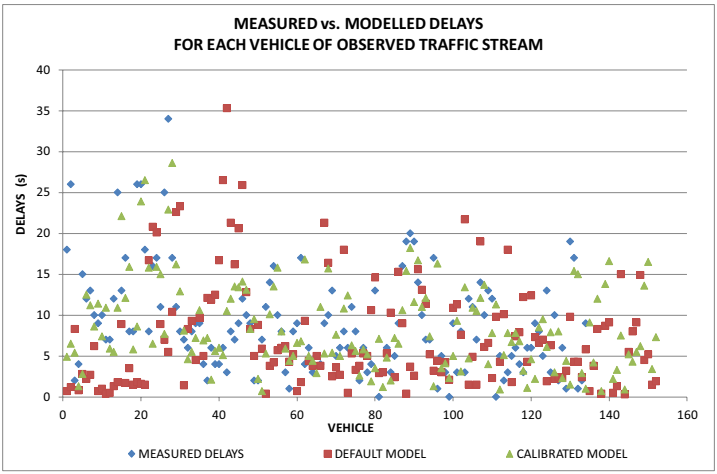
TRAFFIC STREAM LEFT: Drinska-Vinkovačka south		AVERAGE DELAYS (s/veh)
MODELLED VALUES	CALIBRATED	8,4
	DEFAULT	7,3
MEASURED VALUES		8,9

Source: author

The difference between measured data of average delays and modelled data (Table 2) gathered by application of calibrated model is 5.6%, and it is 17.9% by application of non-calibrated model.

The comparison between results of measuring and results of modelling for delays of each vehicle for the observed traffic stream in the given time is given in the Figure 3.

Figure 3 Comparison of modeled and measured delays for each vehicle



Source: author

5. Conclusion

Results of analysis of average delays at Vinkovačka – Drinska roundabout in Osijek by application of the chosen VISSIM model, confirm applicability of microsimulation modelling in local conditions. In the process of delay simulation, compared to measured delays at the intersection, the calibrated model offers better results than non-calibrated one. Analyzed traffic indicator of traffic delays, which is not used in the process of model calibration and validation, offers a valuable insight into a success of the calibration process. At Vinkovačka-Drinska roundabout, the critical traffic, stream which caused long delays at the intersection before the reconstruction (level of service F), has been analyzed. Calibrated model and measurements give 8-9 seconds average delays per vehicle, which implies the highest level of service (A). The conducted analysis shows that the reconstruction of the intersection has made the expected impact on delays at the examined intersection of the primary functional level.

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