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5th International Conference on Road and Rail Infrastructure
17–19 May 2018, Zadar, Croatia

Road and Rail Infrastructure V

Stjepan Lakušić – EDITOR



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University of Zagreb
Faculty of Civil Engineering
Department of Transportation



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Road and Rail Infrastructure V

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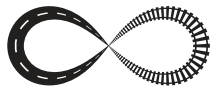
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RESEARCH OF CRITICAL GAPS OF TRAFFIC FLOWS ON FREEWAY INTERCHANGE

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Abstract

The results of the critical gaps research on freeway interchanges in the Russian Federation have presented in this paper. The project finished in 2017 and its main target is to improve the capacity technique. During the period of the Soviet Union, most of interchange design approaches were developed in the middle of the 80th of last century. A lot of things have changed over the past 40 years: daily volumes, structure of traffic flows, cars and trucks dynamic, as well as drivers' behavior. The subject of study is the dependence of the confluence zone capacity of traffic flow from its length. The results of current project allowing to consider the actual traffic conditions at freeway interchanges in Russia and features of drivers' behavior.

Keywords: Freeway interchange, critical gaps, acceleration lane, road design, interchange capacity, confluence zone.

1 Introduction

Currently, the design of freeways and their junctions on the territory of the Russian Federation is carried out in compliance with regulations on designing of automobile roads [1]. Despite the actualisation of this document [2], the design requirements for freeways interchanges at different levels remain unchanged and reflect the approach developed in the 60–80th of the last century [3-5]. The attention to the design requirements for intersections at different levels is not adequate while considering of heavy traffic. Thus, there are no standards and requirements for the design of acceleration bands while taking into account the provision of their throughput, in the rules and regulations on the designing of roads in Russia [1, 2].

A large number of works have devoted to the capacity evaluation of the confluence zones of traffic flows. The works of Drew D.R., LaMotte L.R., Buhr J.H., Wattleworth J.A. [6], B. Silyanov [7], and many other authors are widely known. Changing the dynamics of vehicles, the behaviour of drivers, traffic conditions and other parameters leads to the need for research continuation on the interactions of vehicles traffic flows. The works of Lee G. [8], Shen J. [9], Tian Z. [10] and many others should be noted among the papers currently being conducted. At the same time, traffic peculiarities on the territory of the Russian Federation require verification of the results obtained by foreign researchers, which puts the problem of investigating the throughput capacity of confluence zones of traffic flows on Russian roads. Considering the above, the author set the problem to investigate traffic modes of vehicles within acceleration and deceleration lanes in general and estimate their capacity particularly concerning modern driving conditions on the roads of the Russian Federation.

2 Research method

The authors have carried out research works aimed at studying of critical gaps in confluence zones to estimate the capacity of traffic flows at such zones. The measurements have performed in compliance with the accepted methods of capacity investigation [11, 12] by measuring the gaps for vehicles moving along the right lane of the mainline (T) subject to the adoption of this gap by a driver of the merging traffic flow. The scheme for determining the gap (T) is presented in Figure 1.

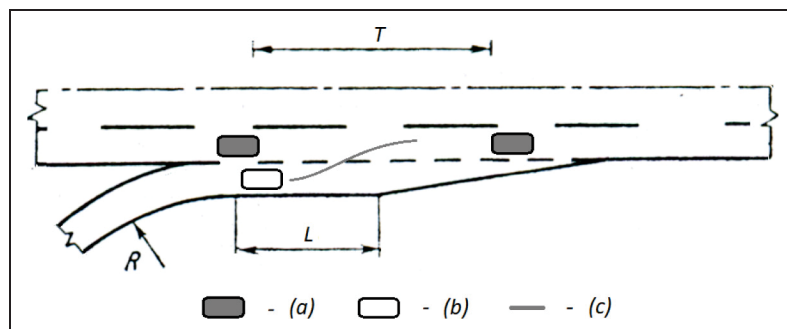


Figure 1 Scheme to determine the gap between vehicles in the observation area: a) is the vehicle moving along the right lane of the mainline; b) is the vehicle of the merging traffic flow; c) is the trajectory of the vehicle

The studies have performed within interchanges at different levels on the roads of Moscow, St. Petersburg, Yekaterinburg and Novosibirsk. The measurement sites were chosen in such a way as to cover the range of practically accepted lengths of acceleration lanes (L) from 20 m to 350 m (see Fig. 1). Measurements of the intervals were made by recording the video of traffic flows in the areas of their confluence zones followed by the post-processing of the records received in the Movavi Screen Capture Studio software [13]. It made possible to determine the interval between cars with the accuracy up to 0.1 s using the software complex. The obtained data on the boundary interval values were presented as the theoretical distribution curves according to Poisson's law corresponding to those obtained during the measurements. Smoothing of the experimental data was carried out by the methods described in [14]. Based on the statistical processing results of the obtained data array, the cumulative curves were constructed, each of which corresponds to one measurement site with a certain length of the acceleration band. An example of such a curve is shown in Fig. 2.

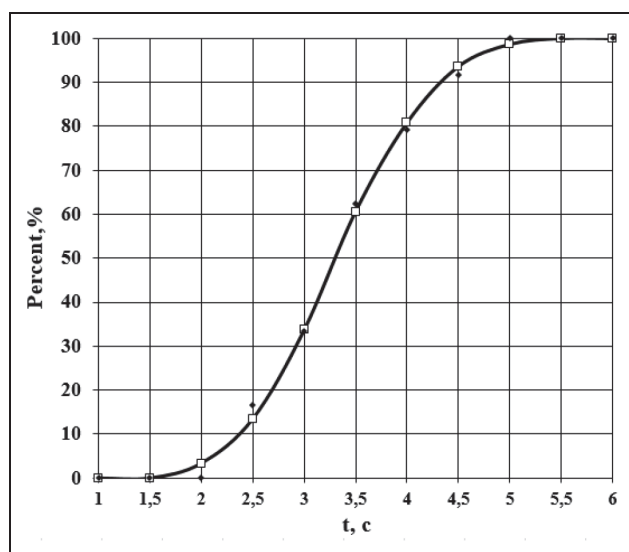


Figure 2 The cumulative curve for the acceleration strip is 60 m long. The vehicle type is the car

Such curves allowed to obtain data on the border intervals between 50 % and 85 % car security. Based on the data on boundary intervals, the author has found the theoretical dependences of vehicle intervals at the acceptance rate of 50 % and 85 % in the areas of traffic flow confluence zones as a function of the confluence zone length in relation to the current traffic conditions in Russia, which are presented in figures 3 and 4.

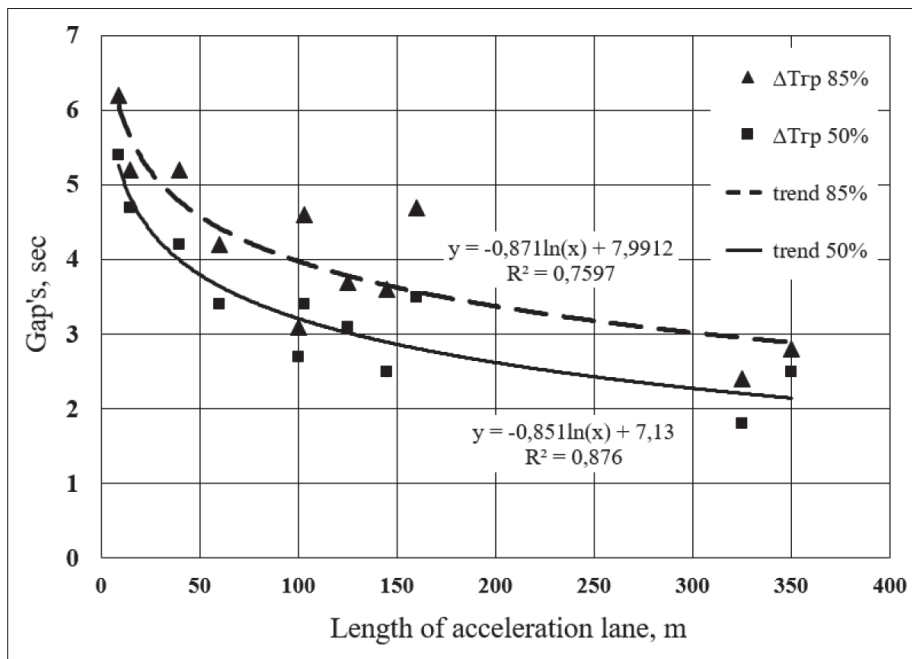


Figure 3 Traffic gaps of cars at the acceptance rate of 50 % and 85 % in confluence zones of traffic flows

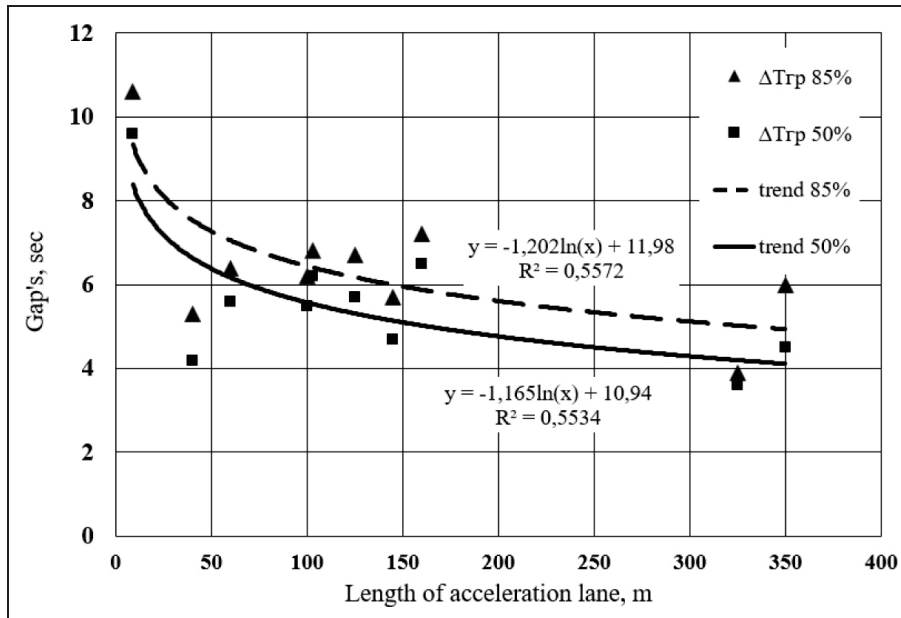


Figure 4 Traffic gaps of trucks at the acceptance rate of 50 % and 85 % in confluence zones of traffic flows

3 Results and discussion

The values of critical gaps have assumed corresponding to the gap of vehicles traffic along the right lane of the mainline, subject to the adoption of this gap by a driver of the merging traffic flow at the acceptance rate of 85 %. The investigation results have indicated a significant im-

pact of the confluence zone length (L) on its capacity: the critical gap is particularly sensitive to the confluence zone length in the length range from 20 m to 100 m: at the zone length from 10 m to 100 m, the critical gap ranged from 4.0 s to 6.2 s for a car and from 6.5 s to 9.7 s for a truck. The confluence zones from 100 m to 350 m in length make less impact on the critical gap: in this range, critical gaps varied from 2.9 s to 4.0 s for a car, and from 5.0 s to 6.5 s for a truck.

4 Conclusions

The critical gap values have established as the functional dependence on the confluence zone length of traffic flow based on the studies carried out: at the lane length from 10 m to 100 m. The critical gap ranged from 4.0 s to 6.2 s for a car and from 6.5 s to 9.7 s for a truck. The boundary intervals varied from 2.9 s to 4.0 s for a car, and from 5.0 s to 6.5 s for a truck, within the confluence zones from 100 m to 350 m in length. The data presented in this paper may be used to justify parameters of acceleration and acceleration bands, including designing of freeway interchanges at different levels. The data may be useful for individual assignment the lengths of acceleration bands in crowded and urban conditions when the placement of the standard-length acceleration bands is impossible for economic reasons and other similar terms.

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