Research of Traffic-Flow Speed on Weaving Sections of Freeway Intersections

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Abstract. Traffic growth on public roads in the Russian Federation requires implementation of new rules and regulations for their design while taking into account heavy traffic flows. Such requirements must be developed on the basis of studies of the traffic flow patterns, including their weaving sections relative to traffic conditions on the country's road system. The results of traffic flow speeds analyses within the bounds of their weaving sections with regard to the traffic conditions in the Russian Federation have presented in this paper. The observation technique has presented, the obtained results have analyzed and conclusions concerning a significant influence of the weaving sections' length on traffic speed provided. The conducted research work allows finding a reasonable approach to lengths regulation of the traffic flows weaving sections while considering their speeds.

1. Introduction

The ongoing automobilization processes of the country's population and, as a result, growth in the traffic intensity on the roads and in the streets of settlements, leads to increase in vehicle delays [1] and other negative consequences [2,3]. For the period 1980-2018, a total number of road accidents has significantly increased while a significant part of them occurs within urban areas [4]. It is noteworthy that main hotbeds of road accidents are located at the road junctions (Figure 1). Consequently, the most important task aimed at improving road safety performance indicators is the improvement of the design standards for road junctions in general and, particularly, freeway interchanges in different levels.

Given that most of the interchanges in different levels contain conflicting points of traffic flows weaving, developing the requirements for the design of such sections is an urgent task aimed at general improvement of road safety indicators on the roads of the whole country.

The review of foreign regulations and rules allows to establish: Despite the fact that in many countries requirements are implemented for the design of weaving sections, the design approach to assignment their perimeters different. In the regulatory and methodological documents in force in the United States [5,6], the requirements to verifying the weaving sections during the development of design solutions have implemented to ensure the estimated traffic-flow speed in accordance with the following expression.

Figure 1. The main hotbeds of road accidents in Moscow, 2016, according to API Yandex.

In the regulatory and methodological documents in force in Germany [7], the requirements for the weaving sections length are in tabular dependence on the estimated design speed of the traffic and the weaving section type have implemented.

Rules and regulations review of the Russian Federation [8,9,10,11] has indicated that there are no rules for assignment parameters for weaving sections of traffic flows in our country.

Considering the foregoing, the author set the task of studying the operation modes of weaving sections. The present research is devoted to the identification of the functional dependence of the motor vehicle speeds on the weaving sections length of traffic flows in relation to road traffic conditions in the Russian Federation.

2. Research method

Taking into account the non-linear nature of the speed changes in the weaving sections of traffic flows, the general nature of the change is described, for example, by Martyakhin D.S. [12]. Measurements of the average speeds of motor vehicles in weaving sections as a part of freeway interchanges at different levels have been carried out within the framework of the present investigations. The average speed measurements of motor vehicles traffic were made by measuring the time interval ΔT for which the vehicle passes the under investigation section of a given length L (Figure 2).

The measurements have carried out using the standard method of measuring average speeds of vehicles by a stopwatch with a measurement accuracy not more than ±1 km/h. The studies were carried out under the conditions of the traffic service level "A" and "B", as corresponding to the free state of the traffic flow. The measurement sections have chosen in such a way as to cover the range of practically accepted weaving sections length of acceleration lanes (L) from 100 m to 500 m. The data obtained during the vehicles traffic observations were recorded on the registration cards with the subsequent processing of the obtained data in the laboratory conditions using mathematical statistics [13,14] using the MS Excel software package.
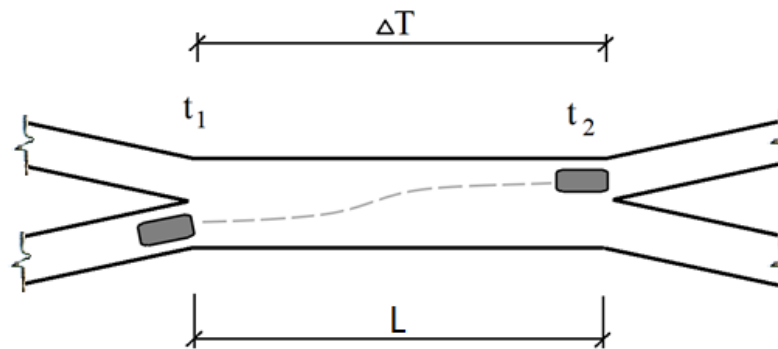
Figure 2. Scheme for determination of motor vehicle speed on the under investigation section. L – is the weaving section length.

3. Results and Discussion

The conducted research works made it possible to propose the dependences of vehicle speeds at the acceptance rate of 85% and 95% on weaving sections of traffic flows in functional dependence on the weaving sections length, which is presented in Figure 3.
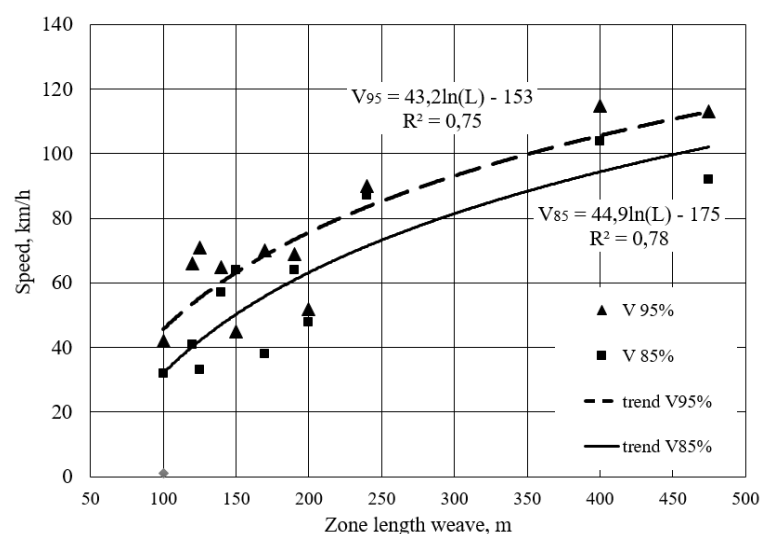

Figure 3. Vehicle speeds at the acceptance rate of 85% and 95% on weaving sections of traffic flows.

The dependences of vehicles speed on the weaved section length have derived at the acceptance rate of 85% and 95% using the regression analysis techniques. A vehicle speed at the acceptance rate of 85% is proposed to be described by the following equation (1):

$$V_{85} = 44.9 \cdot \ln(L) - 175 \tag{1}$$

The vehicle speed at the acceptance rate of 95% – the equation in the form (2):

$$V_{95} = 43.2 \cdot \ln(L) - 153 \tag{2}$$

4. Conclusions

The performed studies have allowed obtaining speed distribution data of vehicles traffic within weaving zones of different length transport flows in relation to traffic conditions in the Russian Federation.

The presented results of research works may be implemented in the design of traffic flows weaving sections, and also for the development of rules and regulations to them for traffic conditions in the Russian Federation.

5. References

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