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Classification Investigations of Traffic Management Schemes Having Conflict Loading at the Signal-Controlled Road Junctions

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Abstract

The results of classification investigations of the efficiency of the traffic management schemes (TMS) are provided according to the criterion of their conflict loading (CL). The latter is determined by types and number of conflict points and maneuvers allowed by the Road traffic regulations in traffic and pedestrian streams. X- and T-shaped one-level signal-controlled junctions (SJ) of streets and roads have been examined in megapolises having various methods of traffic management. Among them there are single-phase management, management in separate directions and combined traffic management in regulatory restrictions of levels of requirements to traffic safety. TMS classification is developed for a complete group of options to formulate and solve the management problems.

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Keywords: signal-controlled junction; traffic and pedestrian streams; traffic management scheme; conflict loading; traffic safety

1. Main text

The issue of developing a methodology to ensure traffic safety (TS) at single-level signal-controlled junctions (SJ) in street and road network (SRN) in megapolises and cities using routine and innovative techniques to manage traffic schemes having conflict loading (TMS with CL) has been in focus of the Russian Federation authorities for a number of years.

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The basic provisions of this methodology include an interconnected complex of specific methods and techniques that can be described as follows [Plotnikov (2014)]:

1. Methods to improve TS at SJ in street and road networks of megapolises and the functional block diagrams describing traffic flow control and assessment (SCA) subsystems that are used to improve TS [Plotnikov et al. (2012), Plotnikov et al. (2013), Plotnikov (2016)].

2. Methods of diagnostic $R_{\Pi л max}$ and rectified $R_{\Pi л}$ traffic safety assessment at SJ [Plotnikov (2013)].

3. Classification studies of TMS having CL for X- and T-shaped SJ using management methods and ensuring meeting the required traffic safety levels (LRTS).

4. Technique to assess levels of required TS and the traffic throughput capacity in X- and T-shaped SJ having opposite direction lanes for different options of TMS having CL and for different types of vehicle maneuvering.

5. Technique to assess the levels of guaranteed TS at two-way X- and T-shaped unregulated junctions for different TMS with CL.

Out of above listed methodology provisions we investigate only the scientifically substantiated engineering and technological solutions mentioned in Item 3. Our approach is based on applying a conceptual framework developed to estimate TS at SJ and the unified data set of data to analyze and develop TMS with CL at SJ which are shown in respective Tables 1 and 2 [Plotnikov (2014)].

Table 1. Existing and developed methods to assess traffic safety at SJ.

Existing methods to estimate junction risk level — Ka (RShel), (unit) [Moscow Automobile and Road Construction State Technical University (MADI), Federal State Unitary Enterprise "Rosdornii" with participation of the Institute of Transport Systems of the Volgograd State University of Architecture and Civil Engineering (2002)], ODM 218.4.005-2010		Scale developed to estimate levels of conflict loading in traffic management scheme at SJ; the levels are equivalent to tiers of required traffic safety (LRTS) - Ka , RShel, RPl, RPlmax (unit)	
less than 3	safe	0 ‑ ⩽3	Higher LRTS — (HLRTS)
3.1–8	low-risk	>3 ‑ ⩽8	Intermediate LRTS — (InLRTS)
8.1–12	risky	>8–≤12	Acceptable LRTS — (ALRTS)
more than 12	highly risky	>12	Unacceptable LRTS — (ULRTS)

It is necessary to use three methods of traffic management **I, II, III:** traditional — single-phase traffic management **I,** traffic management in separate directions **II** and combined (innovative) management **III** [Plotnikov and Kravchenko (2012)] during studies of variable tasks set forth by TMS models with CL at X- and T-shaped SJ under factor space restrictions given in Table 2.

In this situation transport engineers are required developing alternative cases using LRTS rating scale for the following options of TMS models with CL for each of three methods **I, II,** and **III** to manage traffic and pedestrian streams (TPS) at X- and T-shaped SJ crossings in the limited factor space given by Table 2.

I. A single-phase vehicle traffic management in TMS models with CL when duration of green traffic light in main cycles for all directions is identical for each phase being set to the maximum load in a specific phase. TMS models with CL are developed for this method featuring at least two problem solving options out of three potential options to allow the customer choosing one alternative using the LRTS scale criterion, namely: