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Simulation of Traffic Flows on the Road Network of Urban Area

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Abstract

This paper represents some investigation of models, criteria and methods of estimation of current traffic conditions on urban network. These data have been used for studying of reliability parameters of traffic flow for specific urban transport situations at deriving the information from traffic detectors and probe vehicles. Relationships between trip time, stop time, volume of traffic flow, occupancy and capacity have been obtained.

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Keywords: modelling; traffic; road network; service levels intensity – density.

1. Introduction

An important problem of modern cities is the development of methods for assessing the functioning of the road network. To solve this problem, there were developed traffic flow models for specific situations occurring on the urban road network. The purpose of such models is estimation of the travel time and quality criteria for traffic management.

Significant advantages can be obtained using the methods of traffic micro-simulation. Micro-models are used to analyze the delays and capacity of individual elements and parts of the road network. These models use more detailed information on the geometry of roads and intersections, layout features and traffic signalization in comparison with macro-models. The main research area of these problems is the optimal combination of micro and macro models and interpretation of macro-level dependencies for traffic management processes. Despite many studies (Сильянов 1977), there is a need to obtain additional data. The purpose of this paper is to study these techniques.

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Due to significant increase in the level of motorization in Ukrainian cities there have emerged serious traffic problems. Congestion on the road network, traffic delays and stops, traffic accidents, environmental pollution are the main consequences of these problems. Analysis of the characteristics of traffic flows on the main urban highways of Kharkiv suggests that within the time interval from 8–19 o'clock the probability level of service A on the average constitutes 7%. Basically, the arterial streets operate under complex conditions with service levels B and C, which is about 81% of time in the period under consideration. The most difficult situation D in Figure 1, corresponding to congestion states, exist within the limit of 12% during this period.

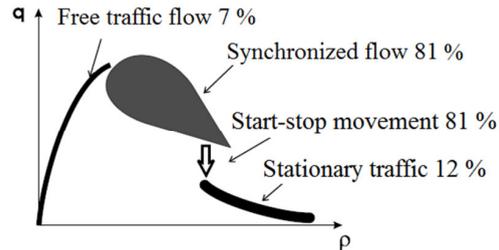


Fig. 1. Phase states of the traffic flow on arterial highways.

One of the most important ways of solving problems is the development of an automated traffic control system.

For integration and development of an automated traffic control system it is necessary to solve the following theoretical and methodological problems:

- to carry out monitoring of traffic flows performance on the road network;
- to determine the levels of service as well as the conditions of congestion occurrence;
- to simulate the distribution of traffic on the road network;
- to define the parameters of forecasting the system efficiency and to analyze the proportion income/expenses.

2. The main part

In many respects the solving of tasks is based on the use of modern methods of traffic flows modelling. The features of traffic flows on the urban road network of big cities are restrictions on the ability to introduce changes with predetermined characteristics of traffic flows. Therefore, modelling of traffic is an important part of the solution of traffic problems and traffic management.

For many years the relationships between the main characteristics of traffic flows is one of the most important theoretical experimental researches in the theory of traffic flows. So far, there have not been eliminated the fundamental contradictions between the factual and its reproduction in the basic models of the traffic flow:

- between the distribution of actual parameters of traffic and deterministic relation in macro-models;
- between the constant value of relationship of critical and maximum density of the traffic flow k_w / k_{max} for each of the models and the variable value k_w / k_{max} in the actual transport flow;
- between the uniformity of relationship between the parameters of traffic flow for each of the models and the change of the functional form for ratios intensity – density, velocity-density.

It is very important that all these contradictions are manifested on the road network of cities. Therefore, the choice of adequate macro models is an important issue.

There were considered a set of multi-parameter models of D. Castillo and F. Benitez and two-component models of the kinetic theory of traffic flow of R. Herman and I. Prigozhin (Herman, Prigozhin 1999). The models of D. Castillo and F. Benitez are adapted to the change of the functional form of dependence intensity – density. Dependences intensity – density are obtained for most types of roads and different situations. The properties of the set of parameters of these models, such as the equivalent distance, generating function, and speed in congestion situations are considered.

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