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The Influence of Human Factor on Congestion Formation on Urban Roads

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Abstract

Road urban transport and traffic engineering in general are long-term discussed topics. Traffic problems are solved from many aspects, such as transport infrastructure, transport organization, high share of car traffic, a negative impact on air quality, emissions etc. Finally, the problem of traffic congestion on urban roads is also highly topical. With increasing economic development of individual states the numbers of cars are increasing as well – the traffic volumes are increasing at the expense of road capacity. The paper deals with the formation of congestion particularly on urban roads, where the driver reaction time influences the size of congestion as well. In the first part of the paper the issues of traffic flow and congestion formation are theoretically discussed. The second part of the paper outlines in practice an influence of human factor (the driver's Perception – Response Time) on the congestion formation.

Keywords: traffic congestion, traffic flow, urban road infrastructure, perception response time of driver

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1. Introduction

Definition of traffic congestion according to the authors Cerna and Cerny is as follows [1]: "Traffic congestion is clustering the vehicles on road section within a traffic network which reduces the throughput and significantly slows the velocity of the traffic flow".

Congestion can be recurrent (regular, occurring on a daily, weekly or annual cycle) or non-recurrent (traffic incidents, such as accidents and disabled vehicles). Economist William Vickrey identified six types of congestion [2]:

- Simple interaction on homogeneous roads: where two vehicles travelling close together delay one another.
- Multiple interaction on homogeneous roads: where several vehicles interact.
- Bottlenecks: where several vehicles are trying to pass through narrowed lanes.
- "Trigger neck" congestion: when an initial narrowing generates a line of vehicles interfering with a flow of vehicles not seeking to follow the jammed itinerary.
- Network control congestion: where traffic controls programmed for peak-hour traffic inevitably delay off-peak hour traffic.
- Congestion due to network morphology, or polymodal polymorphous congestion: where traffic congestion reflects the state of traffic on all itineraries and for all modes. The cost of intervention for a given segment of roadway increases through possible interventions on other segments of the road, due to the effect of triggered congestion.

Formation of congestion is closely related to the density of traffic (see next chapter). When traffic volume approximates the capacity of the road, congestion are generated as well. In cities, this condition becomes mostly during the morning and afternoon peak hours, when the demand for transport is most significant. Figure 1 shows a morning and afternoon peak traffic within the identified traffic volumes during the day on urban road section [3].
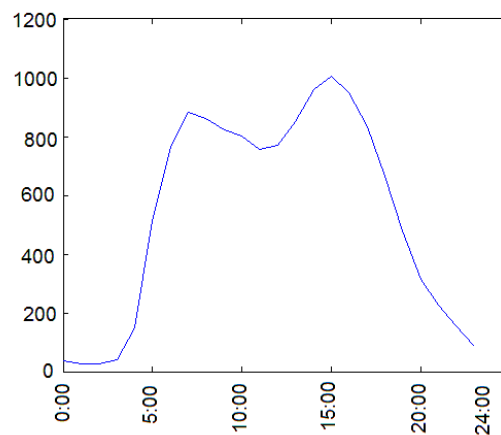

Fig. 1. Day-long traffic volumes determined by authors on urban road section. Source: Authors.

2. Traffic flow theory

For the purposes of this article, the authors demonstrate the macroscopic approach to the traffic flow theory also known as the constant time headway (CTH) model. When applying this model, the idea from the field of traffic safety is considered, i.e. that each reference vehicle keeps a constant distance from the vehicle ahead. Based on this model the characteristics of the traffic flow can be generally determined: velocity v, density k, and traffic volume q (flow) [4].