Evaluation of Pedestrian Motion Safety on Regulated Crossroads

Oleh Hrytsun

Transport Technology Department, Lviv Polytechnic National University, UKRAINE, Lviv, S. Bandery street 12, E-mail: oleggrutsyn1993@gmail.com

Abstract – Conflict situations between traffic and pedestrian flows at regulated crossroads are overviewed in the article. The dependencies of distribution of the number of the pedestrian roadway crossing infraction under the stoplight as functions of traffic intensity are presented. The structural scheme of the factors of conflict situations between traffic and pedestrian flows which directly affect the traffic safety model during the roadway crossing under the conditions of traffic light regulation is proposed.

Key words – pedestrian flow, traffic flow, traffic light regulation, conflict situation, motion safety.

I. Introduction

The organization of pedestrian motion on regulated crossroads and the ensuring of their safety are multifaceted problems. The complicity of solving of these problems is stipulated by the influence of psychophysiological factors which complicate the use of mathematical and mechanical methods of description of pedestrian motion regularities.

The entire complex of technical means, organization forms and methods of traffic control should be the only system aimed at solving of the general problem which consists in ensuring the comfort and safety of traffic participants. In terms of delays minimizing and motion safety improvement, the best conditions of flows passing on the crossroad are spacing traffic and pedestrian flows by means of building of multilevel interchanges (junctions) and of the installation of underground and overground pedestrian crossings. However, this method is very expensive. It is usually related with reformation (restructuring) of the entire traffic system, demolition of buildings, construction of artificial structures and requires huge capital expenditure.

However, under the conditions of limited funding and of inability of making architectural and planning actions, there is a necessity of traffic control (management) taking into account the conflict situations between traffic and pedestrian flows during the crossing (passing) in one regulation phase [1].

II. The Problem of Conflict Situation between Transport and Pedestrian Flows

In some cases, it is not expedient to use traffic light regulation on the roads of lower categories than high-speed roads or main streets with continuous motion because of certain reasons. If the intensity of traffic motion is larger than 600 vehicles per hour and for streets with separator (central reservation, dividing strip) – larger than 1000 vehicles per hour when the number of pedestrians on the crossing exceeds 150 people per hour or when there is high accidence rate on the crossing (3 or larger number of road accidents involving pedestrians per year) it is necessary to construct (build) outstreet crossing. This may be explained by the fact that indicated intensity values for transport and pedestrian flows require the input of traffic light regulation.

The total safety of pedestrian motion is ensured by means of elimination of all conflict situations between transport and pedestrian flows. However, in order to increase the cross-road capacity, sometimes such conflicts are allowed if the total pedestrian flow intensity on one cross-road doesn't exceed 900 people per hour, and total intensity of tilting (swinging) flows which conflict with pedestrians on this crossing is not larger than 120 vehicles per hour [2; 3].

The conflict situations which arise between transport and pedestrian flows on regulated cross-roads may be of four types: with right-turning flows on the cross-road departure; with left-turning flows on the cross-road departure; with right- and left-turning transport flows which uses different traffic lanes of the roadway when departing the cross-road; with right-turning transport flow when entering the cross-road.

In order to evaluate pedestrian motion safety on the regulated cross-road, the empiric formula is used [2; 3]:

$$G_{\Pi} = 0,0025 + 0,92 \cdot 10^{-3} \sum_{i=1}^{n} (N_{\Pi}^{1/4} N_T), \qquad (1)$$

where G_{Π} is a number of road accidents with pedestrians per year; N_{Π} is the intensity pedestrian motion, people per hour; N_T is total intensity of transport flows over the crossing, vehicles per hour; n is a number of pedestrian crossings on the cross-road.

The safety of motion on the regulated crossings also depends on the discipline of pedestrians. It has been discovered that, on average, about 20% of pedestrians violate traffic rules by crossing the roadway under the prohibitive traffic light signal and creating a conflict situation. Road behavior of pedestrians in this case, as we know, is often not predictable because pedestrians are guided by the pursuit of the goal.

The critical waiting time (time of patient waiting) depends on a number of subjective factors: physical and physiological state of the pedestrian, purpose and urgency of his motion, adaptation of pedestrian to traffic conditions, time of day and year, intensity of traffic, the length of the pedestrian crossing etc. The number of violators increases with increasing of prohibitive traffic light signal and with decreasing of traffic intensity. In the publications [2; 3] the calculation value of time of pedestrian patient waiting is about 30-90 s.

III. Evaluation of pedestrian motion safety during the roadway crossing

In order to quantify the critical waiting time there were conducted numerous research of the process of pedestrians roadway crossing in conditions of risk. This will allow to objectively evaluate the use of traffic light signals, which depend on two factors: traffic intensity and pedestrian crossing length (Fig. 1).
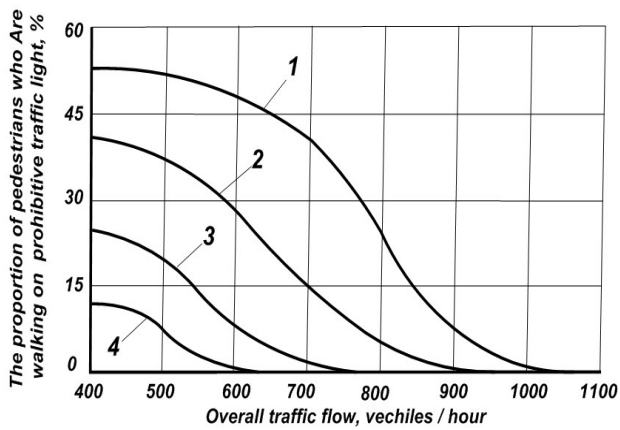
Fig. 1. Results of field research of pedestrian behaviour
on regulated crossings during the day:
1 – two-way traffic; the length of pedestrian crossing
$B_1 = 7.5$ m; 2 – one-way traffic, $B_2 = 11.25$ m; 3 – two-way
traffic, $B_3 = 15$ m; 4 – two-way traffic, $B_4 = 22.5$ m

By analyzing the research results (Fig. 1), we may notice a tendency of decreasing of pedestrians violations when crossing the roadway in conditions of risk increasing, i.e., increasing of traffic intensity and distance length they have to pass. The observations showed that the determining factor when making a decision about the behavior of pedestrians under traffic light regulation is pedestrian crossing length and traffic intensity, i.e., the distribution of intervals between vehicles.

Thus, on the basis of results of this research, it is possible to determine the proportion of people who under almost any conditions cross the roadway, not taking into account the traffic light signals. This is an important information to substantiate the arrangement of various restrictive devices when designing of pedestrian crossings at the same level.

The structure scheme of factors of conflict situations between transport and pedestrian flows, which directly influence the motion safety model during the roadway crossing under the conditions of traffic light regulation, is presented in the Fig. 2.
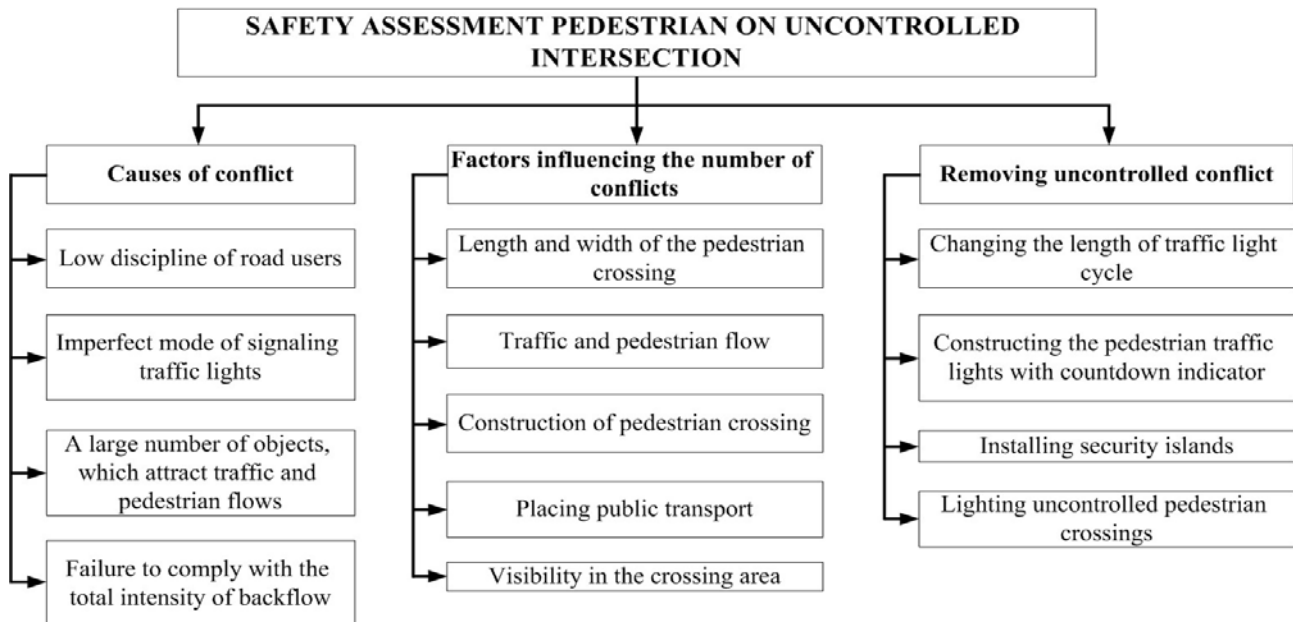

Fig. 2. Structure scheme of factors of conflict situations between transport and pedestrian flows on the regulated cross-roads

Conclusion

The quantitative evaluation of the situation is being carried out on the basis of complex of indicators which characterize safe and comfortable conditions for manoeuvring. When organizing and regulation of traffic it is necessary to ensure unimpeded passing of traffic and pedestrian flows under maximum speeds with minimal delays before the stop-lines of crossroads or pedestrian crossings. Thus, the passing of traffic and pedestrian flows should be based on clear organizing and regulation of traffic taking into account physiological factors of its participants [4].

Therefore, the rational organization (management) of pedestrian motion is one of decisive factors of increasing the capacity of streets and roads and

ensuring more disciplined behavior of people in traffic environment.

References

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