CALCULATION ALGORITHM FOR PEDESTRIAN GREEN TIME

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Abstract: *Places of crossing the roadway by pedestrians, regulated by traffic lights, provided largely safe passage. In these cases attached times of individual signals have to guarantee minimum delay of both streams. The paper presents a calculation algorithm for pedestrian green time according to the intensity of traffic flows and pedestrian flows in certain road conditions.*

Keywords: TRAFFIC LIGHTS, PEDESTRIAN FLOWS, TRAFFIC FLOWS

1. Introduction

The problems of pedestrian and traffic movements must be considered comprehensively. The increase in traffic volume leads to an increase in pedestrian volume, which adds to the conflict [1]. It instigates many problems with traffic management at pedestrian crossing places. In these cases it is necessary to analyze the options for passage of pedestrians and choose the one that provides the least waiting time of vehicles and pedestrians.

2. Prerequisites and means for solving the problem

Signalized pedestrian crossings are used in certain conditions. The lengths of the green signals for pedestrians and vehicles depend on the intensity of pedestrian and traffic flows. To achieve optimal lengths of these signals, an algorithm for their calculation has been developed.

The theoretical formulation is presented for a signalized pedestrian crossing.

The input data for the algorithm are:

- Width of the walkway (B_{ww}), m;
- Length of necessary space for a pedestrian (L_p) – it is assumed to be 0.75 m;
- Width of necessary space for a pedestrian (B_p) – it is assumed to be 0.75 m;
- Width of roadway (B_w), m;
- Length of the car (l_c) – it is assumed to be 5 m;
- Average speed of vehicles at the crossing (V_c) in m/s – it depends on the duration of the green signal and the length of the queue;
- Average speed of pedestrians when crossing the roadway (V_p) in m/s – it is determined according to the speed of the prevailing gender and age of the pedestrians;
- Intensity of traffic flows (I_a^f), veh/s [2];
- Intensity of pedestrian flows (I_a^p), ped/s;

Maximum cycle length ($t_c^{\max}$) in seconds – it is determined according to the existing traffic conditions, the need of traffic light coordination of nearby intersections, regulations, etc.

3. Results and discussion

The algorithm requires initial values for green time for vehicles (t_g^{cs}) and pedestrians (t_g^{ps}) for determining the initial value for the cycle length (t_c^s) that will be subsequently optimized. Thus the condition that the calculated values should guarantee lack of queues of vehicles and/or pedestrians is met.

$$t_c^s = t_g^{cs} + t_g^{ps} + t_{rl}^p + \Delta t + t_y + t_{yr} \text{, s} \quad (1)$$

Where:

t_{rl}^p - The time required for a person to traverse the roadway, s;

Δt - The time from the beginning of the red signal for vehicles to the beginning of the green signal for pedestrians, s;

t_y - Yellow signal duration after green time for vehicles (it is assumed to be 3 seconds at a maximum authorized speed of 50 km/h);

t_{yr} - Yellow signal duration in combination with red signal for vehicles (it is assumed to be 2 seconds at a maximum authorized speed of 50 km/h).

The time required for a person to traverse the roadway guarantees that the last pedestrian to step on the crossing at the end of the green signal for pedestrians will manage to cross the roadway before the beginning of the green signal for vehicles. It is equal to the time required for crossing the roadway:

$$t_{rl}^p = \frac{B_w}{V_p} \text{, s} \quad (2)$$

The number of arriving pedestrians (P_a) and vehicles (A_a) during the cycle duration is determined using the following formula where the calculated values include pedestrians and vehicles arriving from both directions of movement:

$$P_a = t_c * I_a^p \text{, ped} \quad (3)$$

$$A_a = t_c * I_a^f \text{, veh} \quad (4)$$

The values for pedestrian crossing time (t_p^p) and vehicle crossing time (t_p^c) are calculated. The pedestrian crossing time is calculated according to (2), while the vehicle-crossing time is calculated as follows:

$$t_p^c = \frac{S_c}{V_c} \text{, s} \quad (5)$$

Where:

S_c - The distance traveled by a car passing through the crossing – it is equal to the sum of the width of the crossing, the length of the car and the distance from the stop line to the crossing.

When traversing the crossing, it is assumed that the pedestrians move next to each other and one after the other according to the required space for one person.

$$N_{ww} = \frac{B_{ww}}{B_p} \text{, ped} \quad (6)$$

Where:

N_{ww} - Number of pedestrians who can move next to each other along the crossing.

The time after which the next group of pedestrians in a row can start walking (t_b) again depends on the required area for uninterrupted walking along the crossing and on the pedestrian speed. It is determined as follows:

$$t_b = \frac{L_p}{V_p}, \text{ s} \qquad (7)$$

The number of pedestrian groups walking next to each other who can traverse the crossing during the green signal (G) is calculated with the help of the following formula:

$$G = \frac{t_g^p}{t_b}, \text{ ped} \qquad (8)$$

The calculated values allow us to determine the number of vehicles (A_p) and pedestrians (P_p) that pass during the cycle length:

$$A_p = \frac{t_g^c}{t_p^c}, \text{ veh} \qquad (9)$$

$$P_p = G * N_{ww}, \text{ ped} \qquad (10)$$

It can be subsequently determined whether there are remaining vehicles (Q_c) and pedestrians (Q_p) in queue. This is done by analyzing the differences between the number of arriving and passing vehicles or pedestrians for a traffic light cycle, respectively. If in both cases, there are no queues ($Q_c \leq 0$ and $Q_p \leq 0$), the green signal lengths for vehicles and for pedestrians are optimal.

In case there is an accumulation of queues ($Q_c > 0$ and/or $Q_p > 0$), then the green signal lengths for vehicles or for pedestrians are increased by a certain step, respectively. Calculations in the same sequence are performed until values for the queues are reached. This procedure is repeated until both flows are queue-free. A generalized block diagram of the calculation algorithm for pedestrian green time is shown in fig. 1.

In case there is an accumulation of vehicle and/or pedestrian queues even after reaching the end of the cycle ($t_c^{\max}$), we apply the values for green signal lengths where the queue values are the smallest. In cases where the queues are very long and it is difficult for vehicles and pedestrians to pass, other solutions have to be sought for in order for vehicles and pedestrians to cross the relevant section of road.

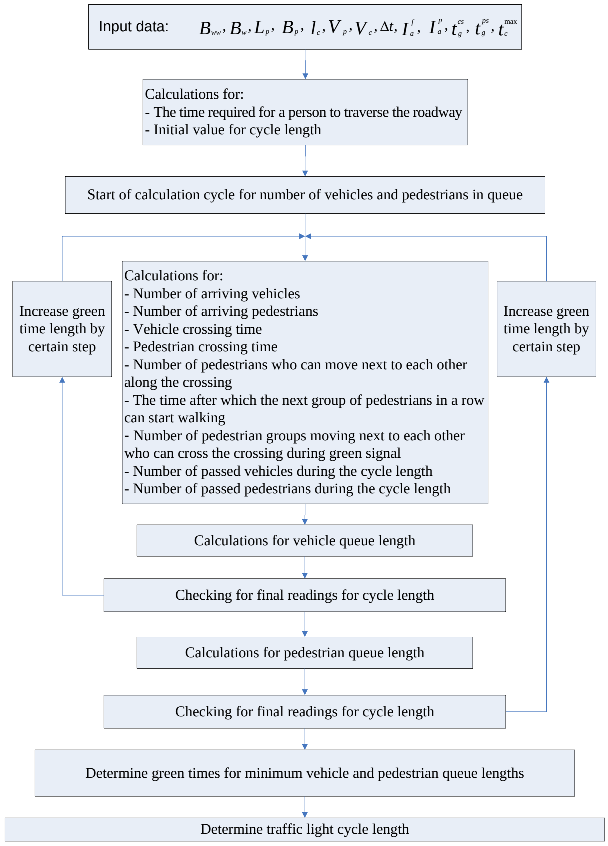

Fig. 1 Generalized block diagram of the calculation algorithm for pedestrian green time

4. Conclusions

The presented algorithm for calculating pedestrian green time has the following major advantages:

1. It can be used for pedestrian movement management in cases where there are technical resources for reporting information about the intensity of traffic and pedestrian flows.
2. It can be used not only for isolated pedestrian crossings.
3. The results it produces can be used to calculate cycle lengths for signalized intersections more accurately.

References

[1] Златанов, И. 1985. Организация и безопасност на движението. София, Техника.

[2] Салиев, Д. (2013). Моделиране на пътнотранспортното движение при на стъпване на аварийни ситуации. Докторска дисертация, ТУ – София, София, България.