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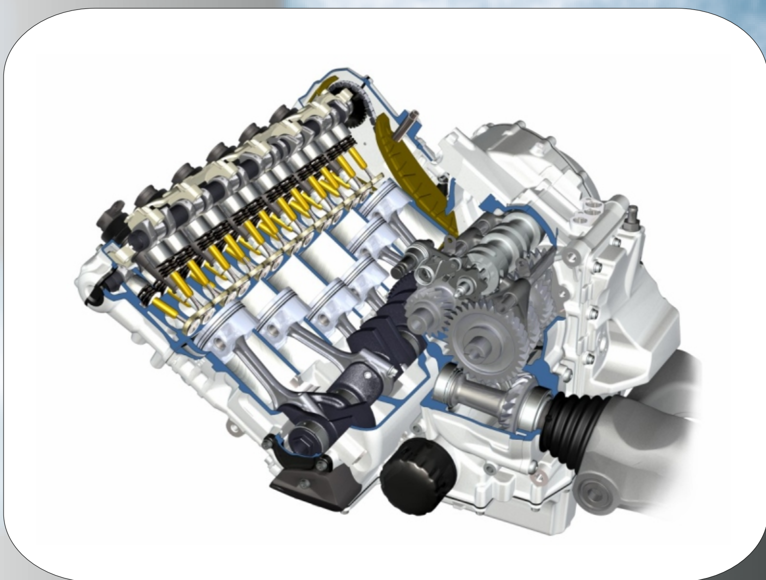

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C O N T E N T S

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CALCULATION ALGORITHM FOR CYCLE LENGTH OF SIGNALIZED INTERSECTION

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Abstract: *Traffic lights regulation reduces conflict points in intersection of traffic flows trajectory and provides their safety crossing. The main in installation of traffic lights is determination of a cycle length which guarantee minimum waiting time of traffic flows at the junction. The paper presents a calculation algorithm for the cycle length of a traffic light junction according to traffic flows intensity, saturation flows and day periods which are have deferent intensity.*

Keywords: TRAFFIC FLOWS, CYCLE OF TRAFFIC LIGHT, TRAFFIC LIGHT JUNCTION

1. Introduction

Traffic lights regulate road traffic across junctions where the conflict zones between traffic flows are not separated from one another. They are applied in order to increase safety and traffic capacity. The major drawback of regulation with traffic lights there is a waiting time of all flows crossing intersection [2]. Traffic light regulation calls for the implementation of certain conditions. The most influential factor when deciding whether or not to use a traffic light at a given junction is the intensity of the traffic flows passing through this junction.

2. Prerequisites and means for solving the problem

The main issue when regulating junctions by traffic lights is how to determine the optimal cycle length for the existing road and traffic conditions. For achieving minimum waiting times, it is necessary to first determine the periods of the day when it is possible to use different cycle lengths to regulate the traffic at a given junction, thus differentiating rush hours from the other periods of the day.

The length of the traffic light cycle is to a large extent affected by the number and type of phases for allowing traffic to pass through a given junction. They are determined according to the specific traffic and road conditions for a given junction as follows:

- Intensity of traffic flows by direction, which largely affects the decision which traffic flow to cross the junction in each of the phases;
- Type of intersection – three-way intersection, four-way intersection, etc.;
- Junction configuration – the width and number of entry and exit lanes are decisive;
- Complexity of the junction – it depends on the number and type of conflict points between traffic flows;
- Others – coordination with other traffic lights, pedestrian crossings, left-turn prohibition and other considerations related to traffic organization in the junction area.

The safe passage of traffic flows between the different phases is ensured by the change intervals, which guarantee that the last car of the exiting traffic flow will have exited the conflict zone by the time the first car of the entering traffic flow reaches it. The change intervals depend on the configuration and geometric dimensions of the junction. From the point of view of crossing the junction safely, their duration is the part of the traffic light cycle which cannot be changed.

3. Results and discussion

The requirement for optimal cycle length was achieved by developing a cycle length calculation algorithm.

The basic input data for the algorithm are:

- Intensity of traffic flows crossing the junction (I_a), veh/s;
- Length of the period of the day whereof the calculations are made (t_{pd}), s;
- Minimum green time for each phase ($t_{g\min}$), s.

The number and type of phases for allowing traffic flows to pass through the junction are determined successively. If traffic lights are available, they may not be changed.

The change periods are determined according to the established conflict zones during changes of phases. One of the methods used for this purpose is described by Moore [3].

The saturation flow is determined based on the calculated change period.

It is assumed that the change period for a given phase (t_{ti}) is equal to the transition time of a vehicle through the intersection (t_{pc}). It is determined with the help of a study which includes measurements of the time that the vehicles in the queue need to set off when the traffic light changes to green. The transition time of each car in the queue and the time between them are both measured. The results show that the headway between vehicles (Δt_{bc}) passing through the signalized intersection is one second.

According to the transition time of a car and the headway, the following values are determined:

$$A_e = \frac{t_{pc}}{\Delta t_{bc}}, \text{ veh} \tag{1}$$

$$t_p = 2t_{pc}, \text{ s} \tag{2}$$

Where:

A_e - Number of vehicles entering the intersection during the transition time of a vehicle, veh;

t_p - Transition time of A_e, s.

The saturation flow of a single lane of the roadway is determined:

$$I_{pl}^{f} = \frac{A_e}{t_p}, \text{ veh/s} \tag{3}$$

The saturation flow is determined by using (4).

$$I_p^f = I_{pl}^f * l_t, \text{ veh/s} \tag{4}$$

Where:

l_t - Number of lanes for the respective flow.

Each flow of the given phases requires enough green time (t_{ng}^{f}) to guarantee its smooth passing during the period of the day for which the calculations are made. The required green light time is calculated as follows:

$$t_{ng}^{f} = \frac{t_{pd} * I_a^{f}}{I_p^{f}}, \text{ s} \qquad (5)$$

After calculations for each flow are made, the sum of the green times required for each phase $\sum_{i=1}^{n} t_{ng}^{f_i}$ is calculated as well, where “i” is the number of phases.

We calculate the sum of all change periods for the whole period of the day for which the cycle length is calculated by using the following equation:

$$\sum\sum_{i=1}^{n} t_{ti} = t_{pd} - \sum_{i=1}^{n} t_{ng}^{f_i}, \text{ s} \qquad (6)$$

We determine the number of cycles for the period of the day whereof the calculations are made (N_{cp}):

$$N_{cp} = \frac{\sum\sum_{i=1}^{n} t_{ti}}{\sum_{i=1}^{n} t_{ti}} \qquad (7)$$

The cycle length is calculated as follows:

$$t_c = \frac{t_{pd}}{N_{cp}}, \text{ s} \qquad (8)$$

After calculating the cycle length, we calculate the green time for each phase of the cycle. For this purpose, the following ratio is used:

$$\gamma_i = \frac{I_p^{f_i}}{I_a^{f_i}} \qquad (9)$$

The green time for each phase is calculated according to (9).

$$t_g^{f_i} = \frac{t_c}{\gamma_i}, \text{ s} \qquad (10)$$

One constraint of the algorithm is the provision of minimum green time for each phase.

A generalized block diagram of the calculation algorithm for cycle length for signalized intersection is shown in fig. 1.

The determined cycle length is optimal for the intersection in the existing traffic conditions. The lengths of the phases can be further optimized by following the algorithm described in detail in [1].

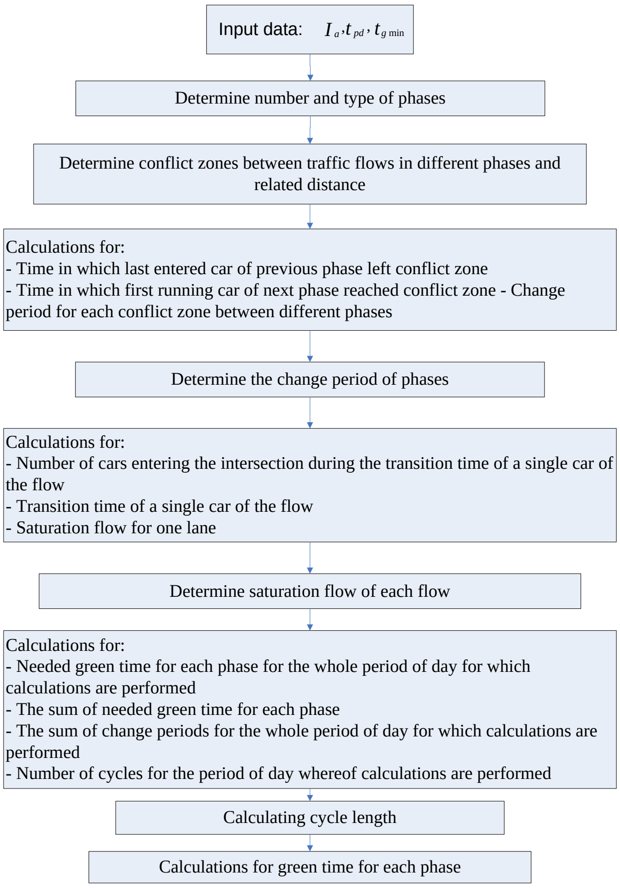

Fig. 1 *Generalized block diagram of the calculation algorithm for cycle length for signalized intersection*

4. Conclusions

The presented calculation algorithm for cycle length of signalized intersection has the following major advantages:

1. Allows calculation of the cycle length for each period of the day regardless of its duration.
2. The input data are determined by a single analysis of the intensity of traffic flows.
3. Little input information is required for the determination of change periods.
4. A value of the cycle length, which is optimal in the existing traffic conditions, is determined.
5. The determined green times guarantee the smooth passing of cars during the given period of the day.

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