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INCREASING INFORMATION AT INTERSECTIONS WITH THE ORGANIZATION OF A SPLIT PHASE DISTRACTS

Prokhorchuk M.
Senior Lecturer
Department of Automotive and Transport Engineering
Zhytomyr Polytechnic State University
ORCID 0000-0003-1154-6589

Abstract. *The article deals with the problems of traffic safety at intersections equipped with traffic signal control, where the time of the permitted signal on one street may have different duration on the approaches to the intersection. This method of organizing a phased junction is effective in cases where there is a significant difference between the traffic intensity on the approaches to the intersection, and the geometry of the roadway does not allow the introduction of a third phase for organizing left turns. This method is also effective in reducing traffic delays at the intersection of large buses and trolleybuses turning left. The article points out such a well-known drawback of this method as the lack of information from drivers about traffic signals in the oncoming lanes. An analysis of the accident rate at intersections with the organization of a split-phase junction in Zhytomyr carried out. Statistical data provided by the Office of the Patrol Police of Ukraine in Zhytomyr regarding road accidents with victims and fatalities that occurred at the studied intersections, data on road accidents with material damage obtained from open sources, in particular Zhytomyr.info, are presented. The results of a survey of professional drivers on their opinion about the need to improve information summarizing. The survey involved drivers of trolleybuses and buses of the Zhytomyr Tram and Trolleybus Department and truck drivers of the companies Humax and Gladkiy in Zhytomyr. Zhytomyr. The generalized survey data indicate the need to introduce additional information devices to indicate intersections where the permitted signal time is different for different directions. As a solution to the problem of increasing the information content at intersections with the organization of a split-phase crossing, proposing to introduce a static sign to be installed on the approaches to the intersection and the use of dynamic boards that would duplicate the signals of traffic lights on the oncoming lane.*

Keywords: *traffic light control, split phase, accident rate, road accidents, asynchronous operation of traffic lights, control phases, traffic light cycle, information content, intersection.*

Introduction.

Intersections are the most important part of the city's street and road network. The efficient functioning of the street and road network depends on the operation of the intersection. Methods of traffic management at intersections should be aimed at providing safe crossing conditions for all road users, as well as at reducing traffic delays when passing through the intersection, as delays lead to economic costs and increased harmful emissions. [1]

To organize safe traffic at an intersection, traffic lights are most often used. The introduction of traffic light control is advisable at a certain ratio of traffic intensity on

the main and secondary roads. Traffic light control minimizes the number of conflict points, helps to reduce delays for road users, and reduces the negative impact on the environment.

An important stage in the introduction of traffic signal control is to determine the number of control phases. The maximum number of phases ensures a minimum of conflict points for the regulated directions, but increases the cycle time and the total duration of additional cycles. Therefore, when determining the number of phases, the specific conditions at the intersection (number and type of conflict points, traffic volume, intersection geometry, etc.) should take into account [1].

The simplest is the two-phase traffic signal cycle. When using a two-phase cycle, left-turning maneuvers carried out in conflict with the forward direction, so at a certain intensity, significant delays in the movement of the left-turning direction may occur.

The literature [1, 2] regulates the expediency of introducing the third phase at a left-turning intensity of 120 units/h. However, if the width of the roadway is insufficient, or if the intensity of traffic in the opposite directions differs significantly, a split phase is introduced, which gives vehicles time to make a left turn at high intensity of oncoming traffic. There are two methods of phase separation: the delayed start method and the early cutoff method.

A significant disadvantage of this method is the lack of information about the traffic signal in the oncoming lane [1]. Therefore, the object of study of the article is the intersections of Zhytomyr city, where a split-phase intersection is organized using the split-phase method. The purpose of the study is to analyze the accident rate at a given intersection and develop proposals to eliminate the shortcomings of this method.

Main text

The split-phase method is primarily implemented within a two-phase signal cycle, without the inclusion of a third signal phase. Instead, a phase-like element utilized. Within such a two-phase cycle, left- and right-turning maneuvers, as well as pedestrian crossings, occur under conditions of conflict with other traffic streams [1]. The integration of split-phase mechanisms into the two-phase cycle does not eliminate these conflicts; thus, turning maneuvers continue to intersect with opposing or crossing

movements. The resulting conflict points at the intersection under a two-phase signal regime are illustrated in Figure 1..

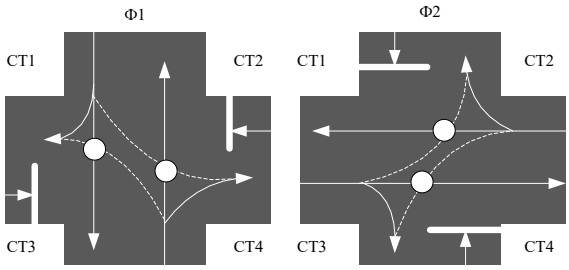

Figure 1-Conflict points in the two-phase cycle of traffic light control

When applying the split phase using the early cutoff method, , since traffic is allowed in only one direction.

In certain instances, a potentially hazardous situation may arise wherein drivers executing a left turn (from direction AB as illustrated in Figure 2), originating from a direction where the green signal duration has been shortened (section A in Figure 2), enter the intersection but are unable to complete the turn before the signal changes. Upon observing the onset of a yellow signal, these drivers may attempt to expedite the completion of their maneuver. However, being unaware that the green signal remains active for oncoming traffic—permitting movement in all directions—they may execute the turn hastily without yielding to vehicles proceeding straight through the intersection on a green signal, thereby increasing the risk of a traffic collision.

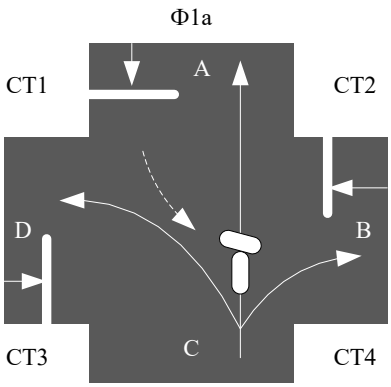

Figure. 2 - Scheme of a possible accident

According to the Zhytomyr City Council, the organization of a split-phase traffic junction is used at the intersections of Velyka Berdychivska Street and Shevchenko Street, Velyka Berdychivska Street and Zhuika Street, Kyivska Street and Nebesna Sotnya Street, Skhidna Street and Nezalezhnosti streets. At these intersections, a phased crossing organized using the early cutoff method. Figure 3 shows a diagram of one of the intersections, the others have similar geometric parameters.

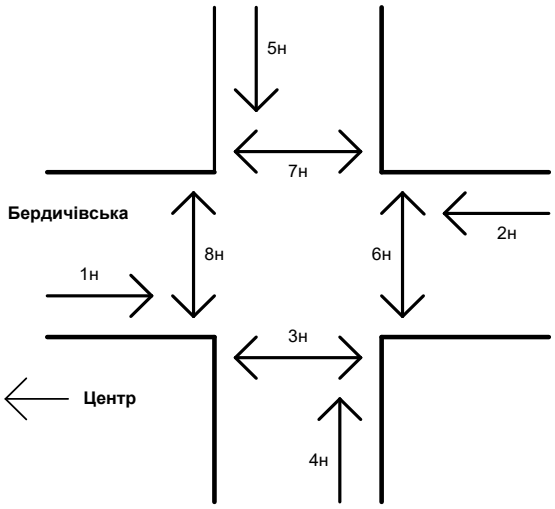

Figure 3 - Traffic pattern of cars and pedestrians through the intersection of V. Berdychivska and Zhuyka streets

The traffic signal operation cyclogram is shown in Figure 4. In the first phase of the control, the permitted signal is extended in direction 2 so that the left-turning direction has time to complete the maneuver.

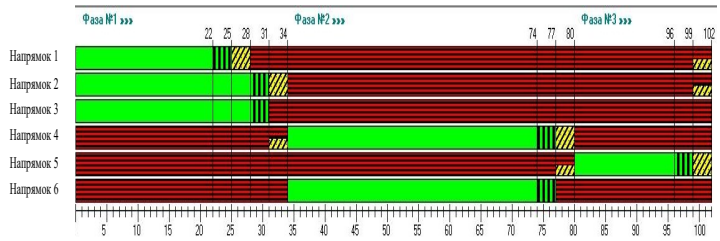

Figure 4 - Traffic signal operation cyclogram at the intersection of V. Berdychivska and Shevchenko streets

According to the information provided by the Patrol Police Department, the following number of road accidents occurred at the study intersections over the period of 10 months in 2024, according to the scheme shown in Figure 4: Velyka Berdychivska and Shevchenka - 3; Velyka Berdychivska and Zhuika - 2; Kyivska and Nebesna Sotnya - 2; Skhidna and Nezalezhnosti - 3. Open sources, such as Zhytomyr.info, also revealed cases of road accidents with material damage, in particular at the intersections of Velyka Berdychivska and Shevchenka - 4; Velyka Berdychivska and Zhuika - 5; Kyivska and Heavenly Hundred - 4; Skhidna and Nezalezhnosti - 3.

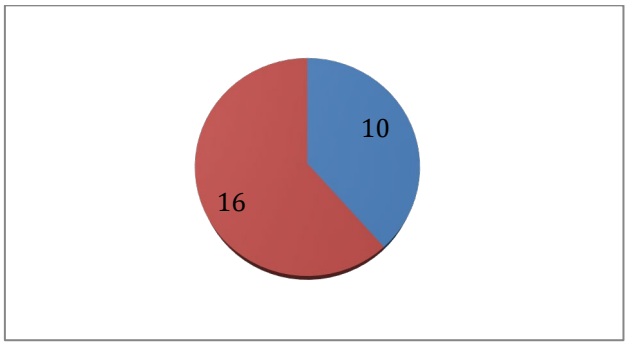

Figure 5 - Number of accidents at intersections in Zhytomyr, with the organization of a split-phase method for 10 months of 2024

People also leave complaints about the non-synchronous operation of the traffic lights, and there are complaints on Zhytmyr.info in the comments to accidents, specifically about the operation of the traffic lights at the V. Berdychivska-Zhuika intersection.

According to the above statistics, it can be concluded that drivers' lack of awareness of the traffic signal in the oncoming lane can lead to accidents.

Based on the statement that the driver is the controlling link in the traffic system of vehicles, which specifically determines the direction and speed of vehicles at each moment of vehicle movement. The more fully and clearly drivers are informed about the conditions and necessary traffic modes, the more accurate and error-free the driving actions of drivers are, and therefore the higher the level of road safety and efficiency

[3]. A survey of professional drivers was conducted regarding the organization of a split-phase interchange organized by the split-phase method. Drivers were asked to answer two questions and had multiple choice answers. Before the survey, a brief explanation of the problem under study was given: "There is a certain organization of traffic light control, in which traffic lights on one road do not work synchronously in different directions. The green light may be extended in one direction and shortened in the other. This is usually using to allow vehicles to turn left and is effective in many cases. However, the disadvantage of this organization is that drivers are not informed about the traffic signal in the opposite lane. Please provide answers to the questions regarding this organization of the traffic signal facility", and then two questions were provided:

1. Do you think that non-synchronous operation of traffic lights can lead to an accident? Answer options "Yes", "No", "My own version"

2. Is there a need to increase information for drivers at intersections where traffic lights do not work synchronously? Answer options: "Yes", "No", "My own version"

The survey conducted among truck drivers of the companies in the private enterprise "Yumaks" and "Gladkyi" and drivers of trolleybuses and buses of the tram and trolleybus department of Zhytomyr. A total of 23 truck drivers took part in the survey. The first question was answered by 75 percent of respondents, while 25 percent did not think an emergency situation was possible.

Regarding the second question, 90% of respondents believe it is necessary to increase information at intersections.

Similar results obtained among bus and trolleybus drivers. A total of 40 drivers took part in the survey. Regarding the first question, 56 percent agreed with the possibility of an accident, 35 percent disagreed, and 9 percent gave their answer. Regarding the second question, 80% of drivers agreed that it is necessary to increase the level of information at intersections where split-phase traffic is organized. 15% of respondents do not see the need for this, 5% provided their own answer, in particular, they suggested the need to inform drivers about the traffic signal in the oncoming lane.

Summary and conclusions. .

Despite its identified limitations, the phase splitting method offers significant advantages over a conventional two-phase signal cycle, particularly in scenarios characterized by uneven traffic intensities across different directions. This is especially relevant when certain vehicles are unable to complete left-turn maneuvers within the available signal time (as illustrated in Figure 4, direction CD), and the implementation of a dedicated turning lane is not feasible due to geometric constraints of the roadway. Furthermore, the phase splitting approach proves effective in intersections involving tram and trolleybus traffic control. Notably, it facilitates a reduction in tram delays by up to 50% and contributes to the optimization of the signal timing ratio between conflicting vehicular and pedestrian traffic flows. Consequently, this results in a 6% increase in the average ratio of permissive signal duration to the total signal cycle time [2].

Therefore, this method of organizing a phased junction should not be rejected, but in order to improve traffic safety at intersections with split phases, it is worth introducing information signs that would attract the attention of drivers when approaching an intersection with such an organization of traffic signal control. It is also possible to install spherical mirrors that would display the signal group of the oncoming traffic lane, or information boards that would duplicate the signals of traffic lights on the oncoming lane.

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