# DELAY EVALUATION IN SIGNALIZED ARTERIAL USING PLATOON DISPERSION MODEL

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## 1. Introduction

Proper choice of intersection control types, such as signalized, roundabout and two-way-stop controlled intersections, in arterial are quite important for achieving higher travel speed from the planning stage. Since in arterial the control types of each intersection affect the performances of adjacent intersections each other, we should have to consider the complicated traffic situations. Therefore, developing a simple methodology to select intersection control types considering link length, traffic volumes and platoon dispersion effect is the basic need. For efficient comparison of intersection control types along the arterial, delay is used the basic measure of effectiveness. Therefore, the purpose of this paper is to propose a framework of arterial delay evaluation method for different intersection types considering the above-mentioned factors and demonstrate the delay evaluation of signalized intersections in under saturation conditions.

## 2. Methodology

The proposed structure of delay evaluation method is mainly divided into two parts. The first part is the calculation of arrival flow pattern from the given departure flow of upstream intersection by considering the propagation of platoon and the second part is the calculation of intersection control delay based on the arrival flow pattern (Fig. 1).

1) Link model: For any types of departure flow profiles in upstream intersection the arrival flow pattern is predicted. Departure flow of upstream intersection is divided into one second step flow and according to the link length, cycle length and platoon dispersion effect, arrival flow profile is determined by using HCM platoon dispersion model[1,2].
2) Intersection delay model: this model evaluates the delay at intersections for the given arrival flow profile from the link model and then the delay and the departure flow profile from the intersection is calculated considering the intersection control type (signalized intersection or roundabout).

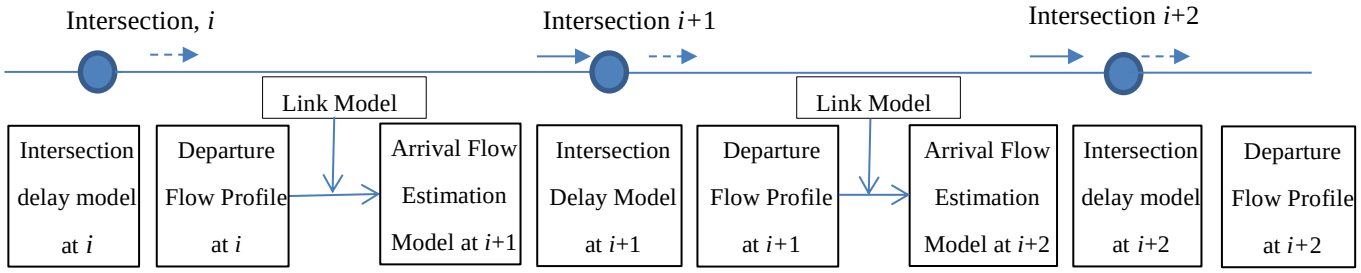


**Fig.1** Delay evaluation structure by link model and intersection delay model

## 3. Analyses and Results

As a simple demonstration of the framework, the link and intersection delay models are applied to the hypothetical intersections which consists two signalized intersections. The link length as shown in Fig. 2 and the input parameters listed in Table 1 is used in this analysis, where no turning vehicles are considered. Cycle length is determined by Webster's formula and the splits are set in proportion to the flow ratio. Two intersection delay models are applied for the comparison; HCM and cumulative curve (CC) methods.

- HCM Method: the proportion of vehicle on green was calculated using the arrival flow profile and then HCM uniform delay model[1] was used to calculate the delay.
- CC method: the average delay was calculated based on the cumulative arrival and departure curve.

The cumulative arrival curve was drawn by the link model as described above. For CC method, the delays without considering the platoon dispersion in the link model is also calculated for the comparison.

**Table 1** Input Parameters

| | | | |
|---|---|---|---|
| Major Flow | **600veh/h** | **Total lost time** | **8sec** |
| Minor Flow | 400veh/h | Cycle length (C) | 40sec |
| Saturation flow rate | 1800veh/h | Green time of major direction | 20sec |

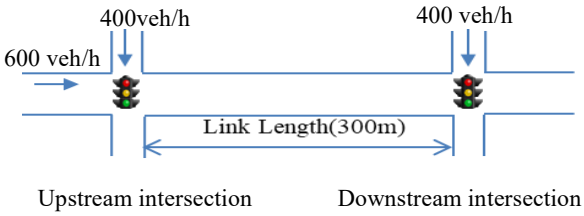


**Fig.2** Hypothetical Signalized Segment

This calculation was done for the several offset cases; 0%, 25% and 50% of the cycle length as well as for prioritized offset as it is equal to free flow travel time of the link.

As shown in the Fig. 3, delay values by HCM and CC with the platoon dispersion are almost the same and the difference of the delays between with and without the platoon dispersion is larger. This imply the impact of platoon dispersion is higher than the accuracy of the approximated results of HCM.

CC without platoon dispersion has larger delay in 0% offset while it has opposite tendency in the other cases. As in the Fig.4, the delay strongly dependent on the number of vehicles which are able to pass during the green. The difference of the number between with and without platoon dispersion varies significantly by changing the offset, which cause this difference.

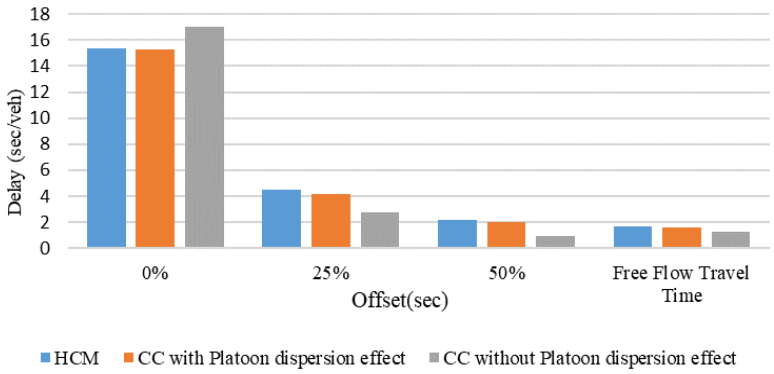


**Fig. 3** Delay at downstream intersection

## 4. Conclusion

In this preliminary analysis, delay was evaluated in signalized arterial by using the link and intersection delay model. It is shown the effect of platoon dispersion causes a significant difference than the difference of intersection delay model. As a future work, more comprehensive study with different link length will be evaluated to develop the general delay evaluation model for arterial consists of the mixture of signalized intersections and roundabouts.

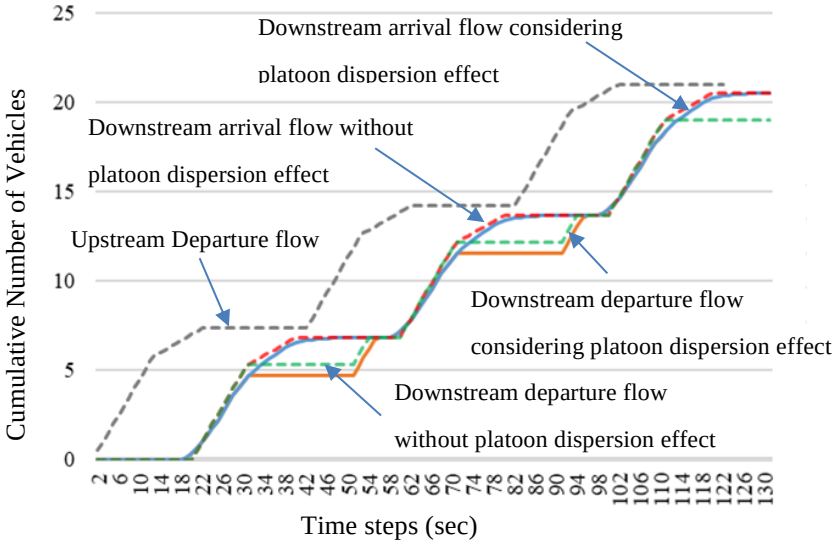


**Fig. 4** Cumulative arrival and departure flow curve (sample case 25% offset)

## 5. References

1) Highway Capacity Manual 6th. *Transportation Research Board, National Research Council*, Washington DC,2016.

2) Bonneson, J.A., M.P.Pratt, and M.A vandehey. *Predicting the Performance of Automobile Traffic on Urban streets*: Final report. National Cooperative Highway Research Program Project 03-79. Texas Transportation Institute, Texas A&M University, College station, 2008.