

THE EFFECT OF OPPOSING FLOW ON THE CRITICAL GAP

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ABSTRACT

The aim of this paper is to establish how to objectively adjust the future critical gaps in SIDRA where the predicted delays might otherwise be unrealistically high. This included investigating how the critical gap, used in SIDRA to calibrate for observed delays, varies with the opposing flow.

This technical note will present the findings from delay surveys for the three typical types of right turn movements at priority intersections. Although the sample size is small the work indicates a reduction in the critical gap when the opposing flow reaches a certain threshold; this significantly influences the predicted delays for future traffic. Our results also show that the critical gap reduces as the arrival position in the queue increases. Interestingly, the critical gap to calibrate SIDRA best matches that for motorists who join the back of the queue at or beyond the 80-95th percentile queue position.

We have discussed our results with Rahmi Akçelik of SIDRA SOLUTIONS and made suggestions for various changes to SIDRA. By the time of the conference we hope to compare our results with those derived from the newly introduced algorithms in SIDRA INTERSECTION 6, and if possible incorporate them in the poster or on a separate hand-out.

INTRODUCTION

This technical note outlines the results of various surveys that captured the delay to right turning traffic at priority intersections. It investigates how the *critical gap* (actually headway) input, used in SIDRA 5.1 to replicate the observed delays, varies with the opposing flow. It also investigates how the critical gap varies with queue position. The results are qualitative and there is likely to be some influence of observer errors.

Tian et al. (1999) stated that the accuracy of capacity estimation is mainly determined by the accuracy of the critical gap. The aim of this technical note is to establish how to objectively adjust the critical gaps for future traffic flows where the default critical gap results in delays that would be unrealistically high, hence reducing the modelled intersection capacity.

METHODOLOGY

MWH carried out keystroke delay surveys based on Wanty (2008) methodology to record both the vehicle flow and right turn delays at state highway intersections in Wellington and Taranaki. This involves an observer whereby for each keystroke recorded (representing a movement or type of vehicle) on a laptop, the time and key pressed are logged. At busy intersections an additional observer using another connected keyboard is usually required.

A spreadsheet tool was developed to analyse the survey data and calculate the flows, turning delays and vehicle queues. SIDRA 5.1 was used to model the various intersections, with the observed turning queuing delays used for calibration. The resulting SIDRA critical gap to replicate the observed delays (follow-up headway was set at 60 % of the critical gap) was plotted against the opposing flow, with the results outlined in the following section.

RESULTS

The findings below are indicative, based on small a sample size of seven T-intersections containing a mix of operating speeds and traffic patterns. Surveys were undertaken during the weekday peak periods. Interestingly the displayed results differ from the SIDRA default values, being in between the four lane and two lane default values.

Critical gap and the opposing flow

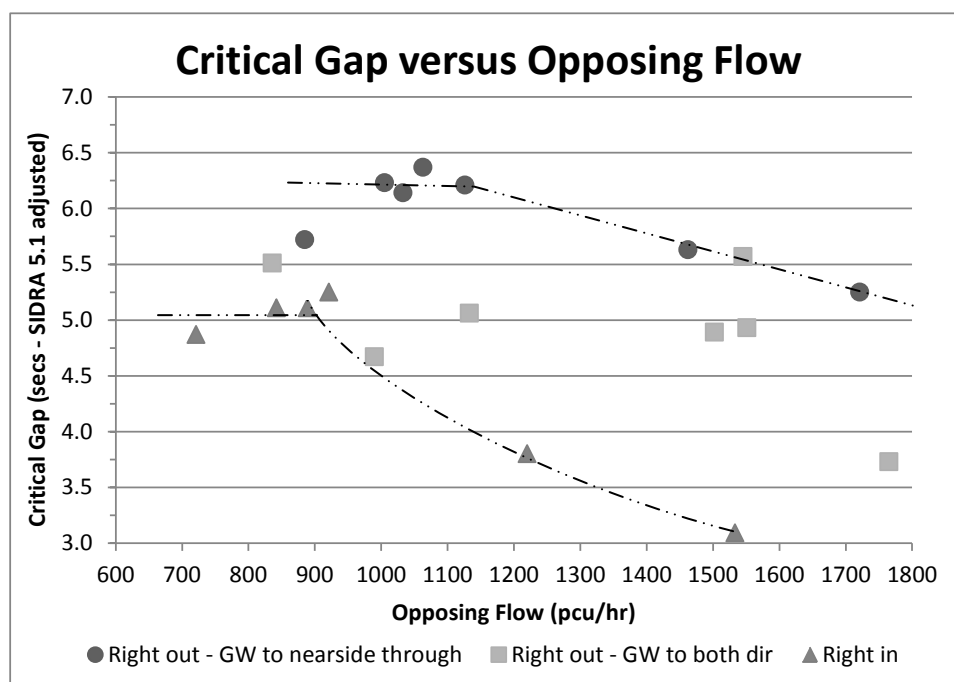


Figure 1: Critical Gap vs. Opposing Flow

The following is a qualitative (professional judgement) interpretation of the findings:

- For situations where there is a central acceleration lane used by motorists turning right out of a side road (give way to nearside through):
 - Critical gap (5½ - 6½ sec) decreases after approximately 1,150 passenger car units per hour (pcu/hr) opposing flow.
- For situations where motorists turning right out give way to both directions
 - Critical gap (5 - 5½ sec) - no obvious trend, too case dependent; however there does appear to be a downward trend with increasing opposing flow.
- For situations where motorists turning right from the main road in to the side road
 - Critical gap (4¾ - 5¼ sec) decreases after approximately 900 pcu/hr opposing flow.

Critical gap versus the minimum queue position

The keystroke procedure (outlined above) that derives the queuing delay also gives the approximate critical gap that varies depending on the initial queue position when the vehicle arrived at the back of the queue. The analysis spreadsheet calculates the delay by initial queue position, and the critical gap for the minimum initial queue position.

The results show that the critical gap reduces as the arrival position in the queue increases. This is best illustrated in Figure 2 and Figure 3 below for a few sites with modest queues. Interestingly, the critical gap used to calibrate SIDRA best matches that for motorists who join the back of the queue at or beyond the 80-95th percentile queue position.

This gap-reduction behaviour, which might be associated with drivers' level of impatience, is supported in the literature by Kimber (1989) and others. However the study conducted by Wong-Toi and Rosser (1994) at a single Tee intersection found the 'impatience effect' to be "barely significant in a statistical sense or as a measurable feature". Their speculation that "a driver at the front of a queue attempting to merge into a heavy line of traffic has probably already decreased a personal critical gap about as far as safety allows", is not inconsistent with our indicative results.

□

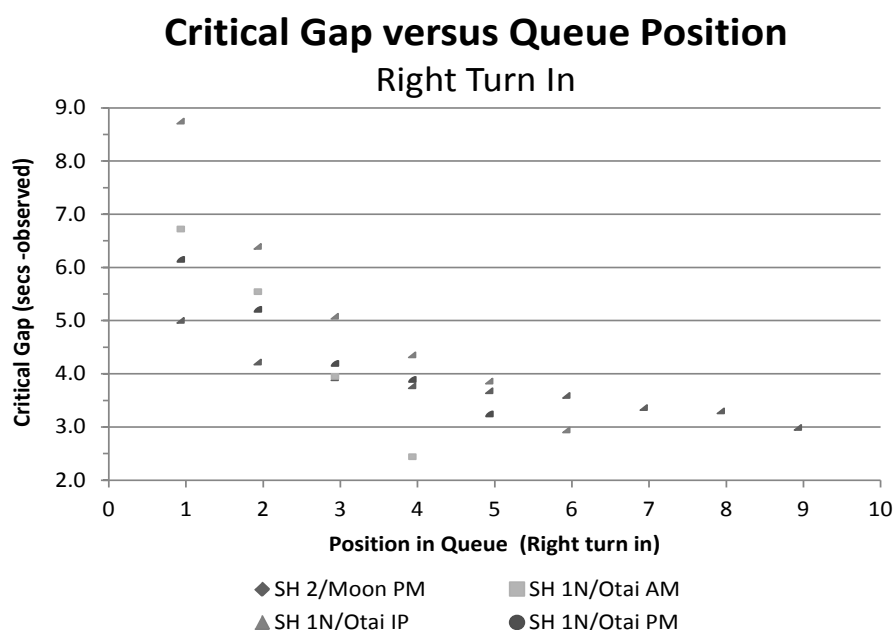


Figure 2: Right turn in - Critical Gap vs. Queue Position

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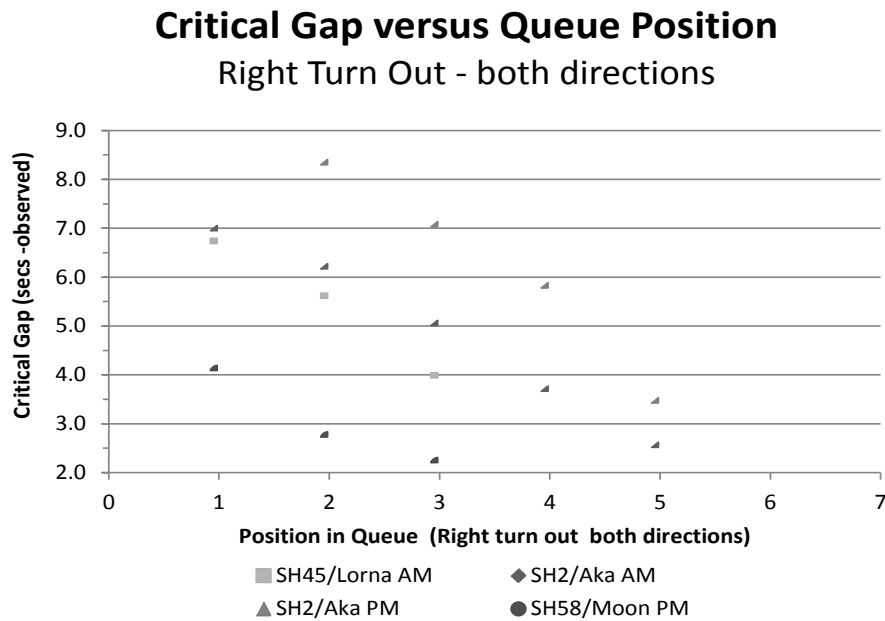


Figure 3: Right turn out - Critical Gap vs. Queue Position

Figures 2 and 3 both show how the critical gap decreases with increasing queue position. Figure 2 shows how the critical gap for all vehicles (minimum initial queue position 1) reduces with increased initial queue position to approximately 3 seconds for queue positions of 5 or more. This trend is evident across the movement types, the various intersections and time periods.

The critical gap drops below two seconds for some right turn out movements when queues exceed six vehicles. These values can be attributed to the observers struggling to maintain input accuracy as the intersection become increasingly busy and the side road queue lengthens, and in part to the spreadsheet procedure when there are few vehicles that arrived in queue position 6, 7 etc.

CONCLUSION

The following conclusions were made as part of the analysis:

- The above findings are qualitative and indicative in nature due to the small sample size. The keystroke analysis procedure currently does not include a separate measure of the time delayed when (only) at the front of the queue.
- There is some evidence that the critical gap chosen by motorists turning right at priority intersections decreases as the opposing flow increases.
- The observed critical gap also decreases with position in the queue (observed delay generally increases with initial queue position).
- The SIDRA 5.1 default values for critical gap do not correlate well with those derived / observed for the small sample of survey sites analysed. For the NZ and Australian situation, the SIDRA default values generally differ from those in the Highway Capacity Manual 2010 and the Austroads Guide to Road Design Part 4A (SIDRA SOLUTIONS, 2011). They also differ from those in the Economic Evaluation Manual (NZTA, 2010).
- The critical gap used to calibrate SIDRA best matches that for motorists who join the

back of the queue at or beyond the 80-95th percentile queue position.

- The findings support the importance of conducting surveys to measure the delays to right turn movements, and not just the turning volumes, at priority intersections. This is of particular importance when undertaking an economic evaluation and considering upgrading the form of the intersection.
- We have discussed our results with Rahmi Akçelik of SIDRA SOLUTIONS and have made suggestions for various changes to SIDRA. By the time of the conference we hope to compare our results with those derived from the newly introduced algorithms in SIDRA INTERSECTION 6.

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