The Effects of Grade on Gap Acceptance at the University Roundabout in Fairbanks, Alaska

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Abstract

Keywords: Gap Acceptance, Greenshields, Raff, Roundabout, Capacity, Grade

The purpose of this study was to analyze gap acceptance at the University roundabout. Values for critical gap calculated from this data can be used to predict the capacity of a roundabout. After videotaping traffic, the data was reduced and analyzed using both Greenshields’ and Raff’s (both graphical and equation based) methods. The variable being evaluated was whether grade of a roundabout approach has an appreciable effect on gap acceptance. After evaluation it was determined that the differences were not statistically significant, and that, therefore, the difference in grade of the approaches did not have an appreciable effect on gap acceptance for the roundabout.

Introduction

In theory, the importance of gap acceptance models is in the models’ predictive function with regards to capacity. “A Review of Gap-Acceptance Capacity Models” identifies critical gap as only one of several key gap acceptance parameters used in capacity analysis. (Askell, 2011) This paper deals only with critical gap, though the data collected allows for further analysis later based on other factors. “Gap-Acceptance and Empiricism in Capacity Prediction” (Kimber, 1989) indicates that gap acceptance models over predict capacity for situations of low flow, under predict capacity at high values, and that behavior in situations of high flow varies by location. Without more studies based in Alaska, this paper cannot account for this discrepancy. This lead the analysis in this paper to be restricted to a scope comprising only gap acceptance analysis, and not the related capacity analysis.

Results

The total number of gaps recorded was 577, with 213 of those gaps accepted and 364 of them rejected. The distribution of gaps was fairly even throughout the observation window, with less than a ten percent difference between the peak fifteen minute interval and the lowest fifteen minute interval on both observed access points.

Data was binned by time interval, then three methods were used to identify the critical gap. For Raff’s method, the numbers of gaps accepted less, and rejected greater than, the time interval bin was plotted for the graphical version of Raff’s method, with the critical gap as the intersection of these two lines. The alternate equation for Raff’s Method (Belz, 2014), \( t_1 + t_2 + \Delta t(m)\), was also used to find critical gap. For Greenshields’ method, the percent rejected gaps greater than gap time 1 was graphed, and the critical gap found as the length of gap which was accepted by 50% of drivers. The results of all of these methods are shown in the figures and table included in this section.

Materials and Methods

Equipment

- Cameras
- iPad for a data collection log
- Computer with Microsoft Excel

Data Collection Methodology

Data was collected during the evening rush hour on Tuesday, February for two access points to the roundabout at the intersection of Tanana Loop West (referred to as West Ridge, for clarity) (WR), West Tanana Drive (WTD), Thompson Drive, and Tanana Loop East. In the figure, recording location is in blue, entrances to the roundabout observed in red, and vehicle arrival point in green (Google Maps, 2014).

Graphical Estimation of Critical Gap Using Greenshields’ Method

Graphical Estimation of Critical Gap Using Raff’s Method for WTD

Graphical Estimation of Critical Gap Using Raff’s Method for WR

Results of Raff’s Method, Equation Based

<table>
<thead>
<tr>
<th>West Ridge Critical Gap (sec)</th>
<th>West Tanana Drive Critical Gap (sec)</th>
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<tr>
<td>5.6</td>
<td>5.27</td>
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Error sources identified include video lag, and human error in recording vehicle time during data collection.

Conclusions

While the results of this study did show a difference in critical gap between the two access points to the roundabout (shown in the figure, below) (Google Maps, 2014), these results were not found to be statistically significant. The null hypothesis of this research project was that there was no statistically significant difference between the two critical gaps. Acceptable gap times were tested using a two tailed t test to see if there was any statistically significant difference, whether higher or lower. With a 95% confidence interval, the results of the t-test showed that there is not a statistically significant difference between the two accepted gaps, and therefore the null hypothesis was accepted.

I identified some areas for future research. This study may have been more conclusive if data was collected over a longer period and from other roundabouts with different approach grades. One area that could use more research for Alaska is the variance between predictions of critical gap analysis and empirical evidence of roundabout capacity for situations of high flow. Another area that could be researched is the impact of the type of vehicle (e.g. car, van, SUV) driven on critical gap, as this could have future implications as smaller, environmental friendly cars become more common. More research in looking at follow up headway as well as critical gap would also be beneficial. For future video-based traffic studies in Alaska, I also recommend that more than one camera be used to reduce lag and view obstruction affecting results.

Keywords:
- Gap Acceptance
- Greenshields
- Raff
- Roundabout
- Capacity
- Grade

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References


