Comparison of Queue Lengths Estimations at AWSC Intersections using Highway Capacity Software, Sidra Intersection, and SimTraffic

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Characteristics of an All-Way Stop Controlled (AWSC) Intersection

- Random vehicle arrivals
- Operate on a first-in/first-out basis
- Maximum capacity: 1,500-1,900 veh./hr. (single-lane intersections)
- Large combination of possible intersection configurations complicates AWSC analysis
Problem Statement

The Highway Capacity Manual (HCM) does not present a methodology for analyzing queue lengths at all-way stop-controlled (AWSC) intersections.

Methodology is only available to analyze queue lengths for two-way stop-controlled intersections through the use of a nomograph in Chapter 17 of the HCM.

The transportation engineering industry currently relies on traffic analysis software programs to estimate queues at AWSC intersections. How accurate are they?
Study Objective

To compare field observations with software-generated outputs to identify the most accurate methodology in predicting 95\textsuperscript{th} percentile queue lengths at AWSC intersections.
Traffic-Analysis Software Programs

1. **Sidra Intersection (Version 3.2)**
   
   - Developed by Akcelik and Associates
   
   - A macro modeling software that uses the HCM 1994 edition as a basis to analyze AWSC intersections
   
   - Queue length outputs are based on determining intersection capacities calculated using the following variables:
     1. Approach volumes
     2. Turning movement proportions
     3. Average total delay
2. Synchro/SimTraffic (Version 6.0):

- Developed by Trafficware

- A micro simulation model that uses the percentile method to predict delays

- Delays based on an evenly weighted average for the 10th, 30th, 50th, 70th, and 90th percentile traffic conditions

- Vehicles are added to a queue in SimTraffic when they are travelling less than 10ft/s and positioned behind a stop bar or queued vehicle
3. **Highway Capacity Software (HCS+) (Version 5.2)**

- Developed by the McTrans Center at the University of Florida.
- A macro modeling software that uses intersection delay as a basis for its signalized and unsignalized intersection outputs.
- Corresponding delays based on the probability a vehicle will encounter conflicting/opposing traffic upon arrival at the stop bar.
Site Selection Criteria

1. Four single-lane approaches
2. No bus loading nearby
3. Minimal pedestrian activity
4. Minimal platooning
Study Intersection Locations (Puget Sound)

- Seattle (7)
- Kirkland (1)
- Bothell (3)
- Shoreline (1)
- Edmonds (2)
- Lynnwood (1)
- Stanwood (1)
- Marysville (1)
Data Collection

1. Recorded queue lengths at 10s intervals over a 60 minute duration
2. Reduced turning movement volume data at a later time from a video source
Sidra Methodology

Enter geometric layout of intersection, traffic volumes, HV%, and peak hour factor to generate capacity and queue length outputs
Sidra Intersection Results

Statistical Analysis

Probability of Underestimation
47%

Root Mean Square Error
2.7 vehicle lengths
SimTraffic Methodology

1. Input traffic volumes, HV%, peak hour factor, and roadway layout into Synchro to generate a SimTraffic Total Delay Report.

2. Follow seeding and recording procedures outlined in ODOT’s Analysis Procedures Manual (APM) (Chapter 8).
SimTraffic Results

95th Percentile Queue Length (Vehicles)

V/C Ratio

Statistical Analysis

Probability of Underestimation
24%

Root Mean Square Error
2.1 vehicle lengths
HCM/HCS+ Methodology

1. Evaluate intersection approach capacity using HCS+

2. Calculate a V/C ratio using HCS+ capacity results and count volumes.

3. Insert V/C ratio into the HCM two-way stop nomograph equation to calculate 95th percentile queue length (in vehicles).

\[
Q_{95} = 900T \left[ \frac{V_x}{C_{m,x}} - 1 \right] + \left[ \frac{V_x}{C_{m,x}} - 1 \right]^2 + \left( \frac{3600}{C_{m,x}} \right) \left( \frac{V_x}{C_{m,x}} \right) \left( \frac{3600}{150T} \right)
\]
HCS+/HCM 2000 Results

95th Percentile Queue Length (Vehicles)

V/C Ratio

HCS+/HCM
Field Observations

Statistical Analysis

Probability of Underestimation
12%

Root Mean Square Error
1.5 vehicle lengths
Summary of Results

<table>
<thead>
<tr>
<th></th>
<th>Probability of Underestimation</th>
<th>Root Mean Square Error</th>
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<tbody>
<tr>
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Study Limitations

• Localized study for the Puget Sound region. Other geographic areas or demographics may operate differently.

• Limited to analysis of four approach single-lane AWSC intersections. Other configurations may operate differently.

• Limited to the use of Sidra Intersection, SimTraffic, HCS+. Other software packages may yield different results.

• Studies were performed during the weekday PM peak period. Other times of the day may yield different results.
Questions?

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