CE 780A: Laboratory Course in Transportation Engineering (Semester: 2019-2020 II)
Lecture Notes

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Experiment 7: Traffic Delays in Signalized Intersections

Revisit the discussion on "Traffic Flow in Signalized Intersections" in the Section 4.4.1 of Chapter 4 of the book "Principles of Transportation Engineering" (Chakroborty & Das, 2018) and the corresponding lecture materials taught in the CE683: Traffic Engineering course.

Introduction: The main objective of this experiment is to study traffic delays of signalized intersection in Kanpur. The number of vehicle arrivals, vehicle departures, queue length, and signal timing information need to be used to measure the traffic delays using (a) queue length information, (b) Webster equation, (c) Highway Capacity Manual (HCM) standards, and (d) deterministic arrival rate with initial queue length. Further, also estimate the saturation headway and capacity of the signalized intersection using the observed data.

Procedure: The study location is the traffic intersection at Bada Chauraha near Z Square Mall, Kanpur. Two video cameras need to be setup at the traffic intersection: one camera facing the arrival of vehicles towards a specific intersection leg, and the other camera facing the departure of vehicles from that intersection leg. Number of vehicle arrivals and queue length need to be measured manually at every 20 seconds interval over the study duration. Simultaneously, green time and cycle length also need to be noted. The data collection should be done for at least 45 minutes to 1 hour. For unequal cycle lengths, the delay can be calculated individually for each cycle length.

Methodology: The observed data at the traffic signal intersection is to be used to estimate delays, saturation headway, and capacity of the intersection leg for each cycle length. The delay can be estimated using the following 4 methods:

1. **Delay estimation using queue length information:**

In this method, queue length (q_i) for each 20-seconds interval (I) is noted along with the total number of vehicles arrival (V_{total}) in the particular cycle length (cl) to determine the average delay ($D_{q,cl}$), as per the Equation (1. Similarly, delay for all cycle lengths observed during the data collection period need to be calculated. Details regarding this method can be found in the Section 4.4.2 of (Chakroborty & Das, 2018).

$$D_{q,cl} = \frac{0.9 \times I \sum_{i=1}^{m} q_i}{V_{total}} \quad (1)$$

2. **Delay estimation using Webster delay equation:**

Use Webster delay equation to calculate average delay for each cycle length (Webster, 1958). Details regarding this method can also be found in the Section 4.4.1 of (Chakroborty & Das, 2018). Note, Webster equation is valid only for unsaturated traffic conditions in the intersection.

3. **Delay estimation using HCM standards:**

Calculate average delay for each cycle length using Highway Capacity Manual 2010 standards (TRB, 2014) for delay determination for signalized intersections, described in Chapter 18 (Equation 18-19).

4. **Delay estimation using deterministic arrival rate with initial queue length:**

Calculate average delay of each cycle using fixed arrival rate with initial queue length (Q_b). Use trapezoidal analysis to determine the area corresponding to delay for each cycle (for unequal cycle lengths and the entire study duration for equal cycle length).

Compare and discuss the delays obtained through each method. Further, also determine the saturation flow and capacity of the intersection for each cycle length, as per the details provided in the reference book (Chakroborty & Das, 2018) in "Collecting Data on Saturation Flow Rate" and "Capacity and level-of-service analysis of signalized intersections" subsections, Section 4.4.1.

Bibliography

Chakroborty, P., & Das, A. (2018). *Principles of Transportation Engineering (Second Edition).* New Delhi: PHI Learning Private Limited.

TRB. (2014). *Highway Capacity Manual 2010, Volumes 1 - 4, including 2014 Errata - Chapter 18. Signalized Intersections.* Transportation Research Board.

Webster, F. V. (1958). Traffic Signal Settings. *Road Research Lab Tech Papers.* UK.