Determining Intersection Traffic Control Using the 1994 Highway Capacity Manual

IN THE 1994 HIGHWAY CAPACITY MANUAL, THE CHAPTER ON UNSIGNALIZED INTERSECTIONS HAS BEEN REVISED, MAKING AVAILABLE THE ABILITY TO DIRECTLY COMPARE INTERSECTION OPERATIONAL RESULTS FOR TWO-WAY STOP CONTROL, ALL-WAY STOP CONTROL AND SIGNALIZED INTERSECTIONS USING A DELAY-BASED APPROACH.

THE PURPOSE OF THIS PAPER IS to provide the practitioner with a guide for selecting intersection traffic control based on peak hour intersection volumes. With the release of the 1994 Highway Capacity Manual (HCM) and the revisions to Chapter 10 on unsignalized intersections, the ability to directly compare intersection operational results for two-way stop-control (TWSC), all-way stop-control (AWSC) and signalized intersections using a delay-based approach is now available.

One of the warrants for traffic signal consideration is the peak hour warrant graphs contained in the Manual of Uniform Traffic Control Devices (MUTCD). Graphs have been developed using a similar format to the MUTCD peak hour volume warrant graphs using minor street volume and major street volume for three intersection operation parameters: 1) intersection level-of-service (LOS); 2) intersection delay; and 3) intersection queuing.

This paper focuses on the application of these graphs by the practitioner as a means to make more informed decisions about traffic control type, supplementing the procedures of the MUTCD. Topics discussed in this paper include an overview of the 1994 HCM procedures, development of the three graphs, interpretation of the graphs and additional information that should be considered in the intersection traffic control type decision-making process.

OVERVIEW OF CONTROLLING MEASURES OF EFFECTIVENESS FOR THREE TRAFFIC CONTROL TYPES

Many important changes occurred with the release of the 1994 HCM, especially in Chapter 10 on unsignalized intersections. Reporting of results for TWSC intersections changed from a "reserve capacity" approach to a delay based methodology, similar to the Chapter 9 procedures. Procedures for analysis of a TWSC intersection are now based on a gap acceptance model developed and refined in Germany. The average total delay for any particular minor movement is a function of the service rate, or capacity of the approach, and the degree of saturation. For a 15-minute analysis period, an estimate of average total delay is given by the following:

\[
D = \frac{3600}{c_{m,x}} + \frac{900T}{V_x} - 1 + \left(\frac{V_x}{c_{m,x}} - 1\right)^2 + \frac{\left(\frac{3600}{c_{m,x}}\right)
}{450T}
\]

where
- \(D\) = average total delay (sec/veh);
- \(V_x\) = volume for movement \(x\), expressed as an hourly flow rate;
- \(c_{m,x}\) = capacity of movement \(x\), expressed as an hourly flow rate; and
- \(T\) = analysis period (hr) (for a 15-minute period, use \(T = 0.25\)).

AWSC procedures underwent many revisions including replacing the tables that contained demand splits and corresponding capacities, lane configurations and capacities for a 50/50 split and LOS "C" volumes for varying lane configurations and demand splits to a delay-based method established on the results of recent research in the United States. Under this methodology each intersection approach is analyzed independently. The average approach total delay is a function of the volume on the approach and the capacity estimated for the...
judgment, however, to determine which traffic control type is most suitable for a particular roadway that is being examined. On arterials with many traffic signals, AWSC may not be appropriate. In other circumstances, it may be appropriate. It is important to always examine the types of traffic control both upstream and downstream to ensure that the selected traffic control type will operate safely and efficiently within the context of other traffic control devices along the roadway.

This procedure can be used as a "quick" method for determining optimal traffic control at an intersection. Of course, data should be collected including turning movement counts and the LOS should be determined to verify the best traffic control as different volume distributions and turning percentages influence the results of the analysis.

This method is not intended to serve as a replacement to the MUTCD but simply to serve as a new tool to help determine the best traffic control type at an intersection. Clearly, these graphs can provide the practitioner with a relatively quick way to look at potential traffic control types.

CONCLUSIONS

The new HCM methods for Chapter 10 on unsignalized intersections now provide the ability to compare intersection control types for TWSC, AWSC and signalized intersections using common MOE's. Optimal intersection control type can be quickly estimated knowing only the major street volumes and high minor street volumes. In addition, results from the analyses reasonably match the MUTCD Figure 4-5, Peak Hour Volume Warrants [population greater than 10,000 and speed less than 40 miles per hour (mph)].

The use of average intersection queue appears to provide reasonable results and is a parameter that can be explained easily. In addition, use of average queue is the product of delay and volume, thus accounting for two variables rather than one.

Additional work needs to be done to examine the effects of number of lanes, the variation of volume splits and distributions. It would be desirable to develop software where optimal traffic control type could be produced by entering the volumes by leg and number of lanes. This method, if kept simple, lends itself well to a nomograph approach, which is clearly understood and accepted.

References


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