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Executive Summary Report

L&D Manual Turn Lane Storage Validation/Update

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Project Background

The formation of queues on a highway facility is a sign of the presence of operationally inefficient sections of the facility. Queuing occurs at intersections in large part due to overflow or inadequacy of turn bays, inadequate capacity, or poor signal progression. The ODOT Location and Design (L&D) Manual Volume 1 has storage requirements for both signalized and unsignalized intersections. Figures 401-9E and 401-10E of the L&D Manual provide the required turn lane storage lengths which should be compared with the real world conditions to check for adequacy of these lengths as a measure of ensuring that accesses to the turn lanes are not blocked. In addition to the projected turn lane volume, ODOT's methodology incorporates both deceleration (based on the speed of the roadway) and potential blockage from the adjacent through lane. Currently, however, there are no records whether these storage lengths computed by the methodology put forth in this manual are valid and accurately represent the actual conditions at intersections in Ohio. Consequently, collecting real world traffic and queue storage data at some intersections and analyzing these data is valuable for validating and/or updating the model ODOT is currently using. Accordingly, the purpose of this research was to collect traffic and queue storage data at some intersections in Ohio and use the collected data to validate and/or update the model in ODOT's L&D Manual.

Study Objectives

The objective of this research study included the following: (1) to use traffic, signal and geometry data collected from some signalized intersections to validate and/or update the current ODOT's model used for turn lane storage length calculations, and (2) to compare queue storage length calculations by other models available such as the McTrans' Highway Capacity Software (HCS) and SYNCHRO using the same datasets.

Description of Work

ODOT personnel video-taped traffic movements at three different signalized intersections in the Columbus area, which resulted into sixteen hours of recording. The recorded video data were manually counted in 15-minute intervals, by turning movements. For the left turn lane in the subject approach (i.e. the approach which is the target of the video camera), the number of vehicles in a queue was counted cycle by cycle. The cycle lengths, the green and yellow indications were observed including counting the number of cycles in each hour. To evaluate the ODOT model of storage length at intersections, the ODOT model calculated queue storage lengths of the study intersections was compared with actual queue lengths observed in the field, with the collected data. The ODOT method computes the storage length at intersections in terms of feet. In addition, the traffic queue lengths observed from field data were also compared with the outputs of the Highway Capacity Software (HCS Version 5.3) and SYNCHRO (Version 7) computer packages as these are some of the widely used software packages. These computer model software packages compute the maximum percentile queues, which represent maximum back distance where vehicles stop during a cycle. The 98th percentile queues computed by HCS were nearer to the maximum observed queues than the 95th queues, therefore, for HCS, the 98th queues were eventually utilized in this study. For SYNCHRO the 95th percentile queues were used.

The model evaluation also involved the evaluation of the level of precision of each of the three models (ODOT, HCS, and SYNCHRO) with respect to the field data observation. The performance of the three models was compared based on two criteria. The first performance evaluation criterion was based on the number of times a particular model's predictions are closest to the actual field observed values. A score value of "1" was given to the model with the best value and a "0" value for the other two. Then a value called "SCORE" was determined for each model by adding together its score values. The second performance evaluation criterion was based on the accuracy level of the prediction, i.e., how close the model predicted queue is to the field-based observed queue length. The value called "%ACC" was determined by computing the absolute percent error for each prediction and subtracting the average of these errors from 100 percent. Based on these formulated evaluation criteria, the higher the SCORE and %ACC values, the better the model in predicting the length of the storage lane.

Research Findings & Conclusions

The L&D Manual model has 8 predictions out of 12 that were closest to the field observed queues when compared to the other two models. Likewise, HCS has a total of 4 predictions out of 12 that were closest to the observed field queues when compared to the other two models. On the other hand, SYNCHRO consistently predicted queues that were much lower than the field observations. The SCORE results are completely supplemented and supported by the accuracy

(%ACC) results, which show that L&D Manual lead the way by accurately predicting the observed queues by about 81.6% and closely followed by HCS, which also had a 79.2% prediction accuracy. SYNCHRO was by far the lowest with a 46.0% prediction accuracy. With the combination of higher accuracy, relatively straightforward procedure, and less data requirement, the L&D Manual method seem to be a more preferred model than the other two evaluated in this study.

Implementation Recommendations

The results from this study are used in suggesting the implementation plan. Although this study was limited in terms of resources and data, the results implicate that the L&D Manual's method of determining storage lengths is valid and reliable. Therefore, it is recommended that this method should continue to be used by all highway design engineers in Ohio who are involved with design projects. However, it is also recommended for ODOT to perform a larger study with the ability to collect much more data from different locations and spanning far more varied traffic levels to validate the results of this study. It is critical to pay special attention during data collection because quality data is a key in such kind of studies especially video queue capturing and reliable traffic signal timings. The choice of intersections to be studied, the approaches to target, and the positioning of the camera are equally important during pre-data collection planning efforts.

There are no potential foreseen risks and costs involved of using the results of this study because it is recommending of continuing using the procedure that has been widely used by engineers at state, local, and consulting firms in Ohio. The benefits are that, engineers will continue using the method they know confidently by getting an assurance that their methodology has been tested and proved to be reliable and valid. The main advantage of the L&D Manual's procedure is that it is relatively simple and straight-forward procedure when compared with most others available and requires less input data.