Abridgment

Platoon Dispersion Characteristics on One-Way Signalized Arterials

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The overall objective of this study was to investigate platoon movements on urban arterials and to relate variation in platoon behavior to variation in signal control and changes in traffic volume.

RESEARCH PROGRAM

The research efforts were structured around four principal phases: (a) review of the literature, (b) collection and reduction of basic data on platoon movement, (c) identification of platoon dispersion characteristics, and (d) model development.

The first phase of research established that the research approach adopted for this investigation is unique; it differs in two important aspects from all previous studies of platoon behavior. These were the collection of comprehensive data on platoon movement by using a helicopter-mounted aerial camera and use of extensive urban signalized arterials as study sites.

The second phase of research consisted of the collection and reduction of continuous velocity and spacing data as platoons of traffic traveled through progressive signal systems during peak hours. Two study sites, each consisting of nine fixed-time signalized intersections, were selected in the Columbus, Ohio, area. Spacing between signals ranged from approximately 107 to 747 m (350 to 2450 ft). For the platoons photographed, vehicle trajectories were constructed to provide visual representations of traffic movement. A total of approximately 28 000 time-space positions were determined and served as the sample data for this study.

The third phase of research consisted of identifying platoon characteristics for traffic traveling on the signalized arterials. It was established that improper signal offsets, the presence of initial queues at interior signalized intersections, and high frequency of lane changes at a specific location can cause inefficiency in the operation of a progressive signal system.

The principal variables affecting platoon movement through linear signal systems were identified as signal spacing, signal offset, and platoon size. It was established that lane of travel exhibits no significant effect on the behavior of platoons traveling from signal to signal. Finally, it was determined as a result of viewing time and space patterns of selected traffic variables that platoon movement can best be described by patterns of mean velocity or mean spacing, traffic density, and the coefficient of variation of velocity.

The final phase of research involved the development of a mathematical model to simulate the behavior of a group of vehicles progressing through a series of signalized intersections. Written in the IBM simulation language, GPSS/360, the model assumptions include passenger car movement, no turning traffic, no entering traffic from adjacent lanes, and no consideration of signal visibility as a factor affecting platoon behavior. These assumptions were made because the study sites for which two models were specifically developed reflected these conditions.

To apply the model to a specific one-way signalized arterial, some field data are necessary to estimate certain variables. The following input is required before the model can be implemented: signal timing at each intersection, signal offset between intersections, distances between signalized intersections, saturation flow at each signalized intersection, lost time at each signalized intersection, storage capacity between signalized intersections, arrival distribution of traffic at the initial signal, and travel-time parameters between signalized intersections. Regression equations were developed to relate the mean and standard deviation of travel-time distributions to signal spacings and signal offsets for a given level of traffic volume.

The model can be used to generate queue, delay, and travel-time characteristics for traffic traveling through the simulated street system. Statistical agreement between observed and simulated queue length distribution for the two study sites revealed the model to be an adequate representation of traffic operations through a signalized arterial.

CONCLUSIONS AND RECOMMENDATIONS

As a result of this research, a method of timing a linear system of signals along a one-way street allowing for the dispersion of traffic is available. Also the effect of a change in linear signal system timing on expected queue lengths and mean delays per vehicle can be predicted.

As a result of this completed investigation of platoon dispersion characteristics, the following recommendations for future research are made: (a) application of the model to the study of additional one-way signalized arterials having different signal spacings and offsets from those of the sites analyzed in this project, (b) generation of a family of regression equations relating travel-time parameters to signal spacings and signal offsets for a variety of traffic volume levels, and (c) a comprehensive sensitivity analysis of all variables incorporated in the model to precisely identify the effect of a change of one model variable on model output.

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