The Ohio Department of Transportation
Office of Research & Development
Executive Summary Report

FIELD TESTING AND IMPLEMENTATION OF DILEMMA ZONE PROTECTION AND SIGNAL COORDINATION AT CLOSELY-SPACED HIGH-SPEED INTERSECTIONS

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Problem

The area close to a signalized intersection, called the dilemma zone, poses a high accident potential for the driver in stopping safely during the yellow interval or in proceeding through the intersection before the beginning of red. Generally, the location of the driver on the intersection approach and the speed of the vehicle influence the driver's decision to stop or proceed when he sees the green signal changing to yellow. The clearing distance is the distance the vehicle travels between the time the signal changes to yellow to the time the signal changes to red. The stopping distance is the distance traveled by the vehicle between the time the signal changes to yellow to the time when the vehicle actually comes to rest. If the stopping distance is greater than the clearing distance, and the vehicle is placed in between them, a dilemma zone is formed. In this situation, neither the distance to the intersection is adequate for stopping nor is the signal interval adequate for clearing the intersection. The driver is in a potentially hazardous situation whereby, if he tries to cross the intersection at the onset of red interval, he may end up in an angle accident with the cross street traffic or if he accelerates through yellow, he may end up in a rear-end collision. The uncertain situation in a dilemma zone can potentially lead to rear-end or right angle collisions.

Objectives

The objective of this study is:

a) To field test and implement a dilemma zone protection technique at a high-speed signalized roadway with closely-spaced intersections; and
b) To recommend a method for reducing dilemma zone problems that can be implemented by ODOT and cities/municipalities in Ohio.

Description

The testing and implementation of the dilemma zone protection technique was carried out at three high-speed closely-spaced intersections on Roosevelt Blvd in Middletown, Ohio. Several factors that affect dilemma zone problems were considered: (a) length of dilemma zone, which allowed for vehicular speeds ranging from 45 mph (72.41 kmph) to 60 mph(96.54 kmph); (b) detectors, which were located at 300 ft (91.44m) or 600 ft (182.88m); (c) green extensions, which varied from 1 sec to 5 sec in increments of 1 sec, with the "no green extension" being used as the base case; and (d) vehicle conflicts caused by (i) running red light (ii) stopping abruptly or (iii) accelerating through yellow representing the dilemma zone problem. The traffic data was collected during off peak hours in the morning (9am – 11am) and at night (8pm – 10pm). In all, 288 hours of data were collected on the six intersection approaches.

Conclusions & Recommendations

The study indicated that the three types of conflicts namely, running red light, stopping abruptly and accelerating through yellow can be successfully used to identify vehicles that experience dilemma zone problems at signalized intersections. It revealed that that accelerating through yellow was the major conflict for all intersections, followed by running red and stopping abruptly respectively. Overall, this study has shown that, for the roadway segment of Roosevelt Blvd between Highland and Armco, which has a speed limit of 45 mph (72.41 kmph), dilemma zone protection can be effective by placing detectors at 300 ft (91.44m) and providing a green extension of 3 sec on most, but not all, approaches. The effectiveness was more evident during the morning period than during the night period. The study shows that there is no one "universal" rule for dilemma zone protection that would apply equally to all intersections because each intersection is unique in its geometric and operational characteristics and vehicular speeds on any intersection varies within a wide range. Recommendations for implementing the technique for future improvements of intersections identified with dilemma zone problems have been made.

Implementation Potential

The technique used in the present study is simple to implement, and can be used at most of the intersections requiring the use of a detector. Vehicle detection can be provided by using loop detectors, if necessary, instead of video detectors as was done in this study. If the base conflict rate is relatively high, this technique has the potential of reducing dilemma zone problems if it is judiciously implemented.