In the United States, intersection-related crashes are among the most frequent locations for crashes. One of the major problems at signalized intersection is the dilemma zone, which is caused by false driver behavior during the yellow interval. This research evaluated driver behavior during the yellow interval at signalized intersections and compared different dilemma zone countermeasures. The study was conducted through four stages.

First, the driver behavior during the yellow interval were collected and analyzed. Eight variables, which are related to risky situations, are considered. The impact factors of drivers’ stop/go decisions and the presence of the red-light running (RLR) violations were also analyzed.

Second, based on the field data, a logistic model, which is a function of speed, distance to the stop line and the lead/follow position of the vehicle, was developed to predict drivers’ stop/go decisions. Meanwhile, Cellular Automata (CA) models for the movement at the signalized intersection were developed.

In this study, four different simulation scenarios were established, including the typical intersection signal, signal with flashing green phases, the intersection with pavement marking upstream of the approach, and the intersection with a new countermeasure: adding an auxiliary flashing indication next to the pavement marking. When vehicles are approaching the intersection with a speed lower than the speed limit of the intersection approach, the auxiliary flashing yellow indication will begin flashing before the yellow phase. If the vehicle that has not passed the pavement marking before the onset of the auxiliary flashing yellow indication and can see the flashing indication, the driver should choose to stop during the yellow interval. Otherwise, the driver should choose to go at yellow duration. The CA model was employed to simulate the traffic flow, and the logistic model was applied as the stop/go decision rule. Dilemma situations that lead to rear-end crash risks and potential RLR risks were used to evaluate the different scenarios.

According to the simulation results, the mean and standard deviation of the speed of the traffic flow play a significant role in rear-end crash risk situations, where a lower speed and standard deviation could lead to less rear-end risk situations at the same intersection. High difference in speed are more prone to cause rear-end crashes. With Respect to the RLR violations, the RLR risk analysis showed that the mean speed of the leading vehicle has important influence on the RLR risk in the typical intersection simulation scenarios as well as intersections with the flashing green phases simulation scenario.

Moreover, the findings indicated that the flashing green could not effectively reduce the risk probabilities. The pavement-marking countermeasure had positive effects on reducing the risk probabilities if a platoon's mean speed was not under the speed used for designing the pavement marking. Otherwise, the risk probabilities for the intersection would not be reduced because of the increase in the RLR rate. The simulation results showed that the scenario with the new countermeasure, which adds a flashing indication next to the pavement marking, had less risky situations than the other scenarios with the same speed distribution. These findings suggested the effectiveness of the new countermeasure to reduce both rear-end collisions and RLR violations than other countermeasures.

Major: Civil Engineering MS

Educational Career:
Bachelor’s of Traffic and Transportation, BS, 2012, Beijing Jiaotong University
Committee in Charge:
Mohamed Abdel-Aty, Chair, CECE
Jaeyoung Lee, CECE/CECS
Naveen Erulu, CECE/CECS

Approved for distribution by Mohamed Abdel-Aty, Committee Chair, on September 26, 2014.

The public is welcome to attend.