Identifying Effects and Applications of Fixed and Variable Speed Limits

Introduction

In Indiana, distracted driving and unexpected queues have led to an increase in the amount of back-of-queue crashes, particularly on approach to work zones. This report presents new strategies for the assessment of both transportation safety and traffic operations using crowdsourced probe vehicle data and a speed laser vehicle re-identification scheme. This report concludes by recommending strategies for the placement of variable speed limits (VSL) adjacent to work zones and suggestions for future research.

The first portion of this study characterizes the back-of-queue concerns using a new assessment technique based on crash reduction factors. Crash reduction factors are widely used by engineers for prioritizing safety investments. Work zones are routinely analyzed by the length and duration of queues. Queue detection warning technology has been growing in availability and reliability in recent years. Three years of crash data and crowdsourced probe vehicle data were analyzed to classify crashes as being associated with queueing conditions or free-flow conditions. In 2014, only 1.2% of the distanced-weighted hours of operation of Indiana interstates operated at or under 45 MPH. A three-year study on Indiana interstates indicates that commercial vehicles were involved in 87% of back-of-queue fatal crashes compared to 39% of all fatal crashes during free-flow conditions. A new measure of crash rate was developed to account for the presence and duration of queues: crashes per mile-hour of congestion. The congested crash rate on all Indiana interstates in 2014 was found to be 24 times greater than the uncongested crash rate. Queues were found to be present for five minutes or longer prior to approximately 90% of congestion crashes in 2014. This information shows the importance of developing technology that can warn motorists of traffic queues.

Lastly, portable variable speed limit signs were deployed adjacent to a work zone in southern Indiana and an empirical analysis was done to develop best practices. This report presents a new methodology to evaluate the impact of variable speed limit signage based on individual vehicle-matching. The speeds and speed changes of these matched vehicles were used to analyze individual driver response to the variable speed limits. The new vehicle-matching methodology showed that after
observing a 15 MPH speed drop on a single variable speed limit sign for cars (10 MPH for trucks) over three separate variable speed limit signs, cars reduced their speed by a median of 3.3 MPH (2.1 MPH for trucks). Overall, 3.5% of cars and 11.1% of trucks complied with the 55 MPH speed limit after observing three variable speed limit signs. Using a similar assessment strategy, variable speed limit signs were deployed in pairs and evaluated. Sign pairs consist of two portable variable speed limit signs in one location, one on each side of the roadway. When assessing a similar 15 MPH speed drop (10 MPH for trucks) it was discovered that three sets of paired signs are more effective in slowing down vehicles, with reductions of 4.7 MPH for passenger vehicles and 2.7 MPH for trucks relative to three individual signs. Compliance rates after the three sign locations were 3.3% and 9.1% for cars and trucks, respectively.

**Findings**

The final recommendations gathered for this study include:

- Paired variable speed limit signs outperform single signs when attempting to slow vehicles.
- Operators and managers should use at least three pairs of variable speed limit signs to obtain any tangible reduction in driver speeds.
- Variable speed limit signage should be placed upstream of the expected back-of-queue location.
- Placement of variable speed limit signage can be actively monitored using crowdsourced probe vehicle data.
- Future work should be considered including automating the speed limits on the variable speed limit signage.

**Recommended Citation for Report**


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