Project Summary

Texas Department of Transportation

0-5913: Feasibility of Speed Harmonization and Peak Period Shoulder Use to Manage Urban Freeway Congestion

Background

Traffic congestion is an increasing problem in the nation's urban areas leading to personal inconvenience, increased pollution, hampered economic productivity, and reduced quality of life. While traffic congestion tends to continuously increase, growth in transportation infrastructure is limited by financial and land availability constraints. This has placed an increasing emphasis on using active traffic management strategies, such as speed harmonization and peak-period shoulder use, to efficiently manage congestion using existing freeway capacity. This research implemented different strategies of variable speed limits (VSL) and shoulder use and evaluated their impact on traffic operations and safety. It also provided a feasibility analysis and a cost-benefit analysis framework for implementing these strategies in Texas.

What the Researchers Did

To accomplish the purpose of the project, researchers:

1. surveyed past experiences with speed harmonization and peak-period shoulder use across the globe,
2. identified a test corridor in Texas to determine the feasibility of these active traffic management strategies in the state,
3. developed a microsimulation model to study the operational and safety benefits of these strategies,
4. presented a framework for evaluating the impact of offline variable speed limits on performance measures,
5. developed a code to interactively implement variable speed limits in real time based on prevailing traffic conditions,
6. implemented peak-period shoulder use in conjunction with both the offline and online VSL and evaluated their impact on traffic operations and safety,
7. developed and implemented a multi-resolution framework to study the impact of these strategies at network level,
8. provided recommendations on ITS requirement, enforcement, and potential impediments in their implementation, and
9. presented a cost-benefit analysis (CBA) framework and operational deployment plan for variable speed limits and peak-period shoulder use.

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What They Found

The impact of speed harmonization and peak-period shoulder use on freeway traffic was classified into two broad categories: traffic operations and safety. The results obtained from different implementation strategies (offline VSL, online VSL, and VSL with shoulder use) were consistent with each other and in general agreement with existing literature.

Impact on traffic operations: Variable speed limits and shoulder use did not have significant impact on throughput of the freeway. These strategies homogenized traffic stream and resulted in a smoother flow of traffic by reducing the total number of stops per vehicle, stopped delay, and number of lane changing maneuvers. VSL resulted in speed harmonization by reducing speed variability, and shoulder use contributed to this by reducing the density of traffic flow. These benefits were greater if VSL and shoulder use were implemented early on and before the onset of severe congestion. Once congestion sets in the speed of traffic is governed primarily by the prevailing traffic condition instead of displayed speed limits.

VSL and shoulder use reduced the average speed of traffic in the test corridor and contributed to a small increase in travel time. Shoulder use had an adverse effect on speed at the end of the shoulder-use section. This is due to a sudden drop of shoulder use at the section end which created a bottleneck.

Impact on traffic safety: The safety implications of VSL and shoulder use were assessed using three crash precursors: coefficient of variation of speed (within and across lanes) and traffic density. VSL created safer driving conditions by reducing all three crash precursors. Shoulder use also contributed to safety by significantly reducing speed variability (within the lane) and traffic density. However speed variability (across lanes) increased due to additional lane changing maneuvers to and from the shoulder to the regular lanes, thereby creating an adverse effect on safety.

What This Means

This research is the first of its kind which implemented variable speed limits and shoulder use simultaneously to study their impact on traffic operations and safety. VSL and shoulder use homogenized traffic and reduced stop-and-go conditions by moving the traffic more steadily. Based on the research findings of this study, it can be concluded that VSL and shoulder use have potential to make the freeway safer because they reduced crash precursor values in most cases. This is further supported by the observation that the use of these strategies results in a smoother traffic stream with less number of lane changes and stops per vehicle. Smoother flow of traffic results in less emission, less fuel consumption, and less wear and tear for vehicles and leads to safer driving conditions. This study also provided recommendations on ITS devices requirement, enforcement issues, potential impediments in their implementations, and a framework for cost-benefit analysis to determine the economic viability of the project.

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