National Center for Sustainable Transportation

POLICY BRIEF

Using Combined Lane Change and Variable Speed Limit Control Techniques Can Ease Congestion and Reduce Fuel Use and Emissions

Petros Ioannou and Yihang Zhang
Viterbi School of Engineering, University of Southern California

February 2020

Issue

Traffic during peak hours is getting worse over time and the duration of the peak is increasing in most metropolitan areas as more drivers try to use limited roadway capacity. Bottlenecks caused by traffic incidents or road construction limit roadway capacity even further and can cause traffic "shock waves." When an incident causes a highway lane to close unexpectedly, vehicles are forced to change lanes close to the incident and at low speeds. These forced lane changes interfere with traffic flow in open lanes and decrease the overall flow of the roadway (Figure 1). Heavy-duty trucks can exacerbate congestion because they are larger and slower than passenger vehicles.

Advanced technologies may help to improve traffic flow in these situations. **Variable speed limits** can change based on road, traffic, and weather conditions. Speed limits can be reduced in real time when congestion is imminent to smooth traffic flow and handle more traffic volume at a slower, but not stop-and-go, speed. **Lane change control** systems provide lane change recommendations well upstream of blocked lanes, spreading lane changes over a greater distance and minimizing bottlenecks that disrupt traffic flow. Speed limit and lane change information can be displayed via overhead or roadside digital signs.

Researchers at the University of Southern California simulated traffic patterns along a section of Interstate 710 near the Ports of Long Beach/Los Angeles, a congested area that gets substantial truck traffic. They simulated the use of variable speed limit and lane change control systems to evaluate the potential traffic impacts of these systems.

Key Research Findings

Researchers found that the two systems work best together, and can produce several benefits when combined.

A combination of variable speed limits and lane change control systems can reduce stop-and-go traffic and improve travel time. Variable speed limits on their own can smooth traffic flows, but these benefits can be lost by a single slow-moving truck making a lane change in the vicinity of a bottleneck. Combining variable speed limits with upstream lane change recommendations reduced travel times by 25%–36% and reduced the number of stops by 90% in traffic simulations.

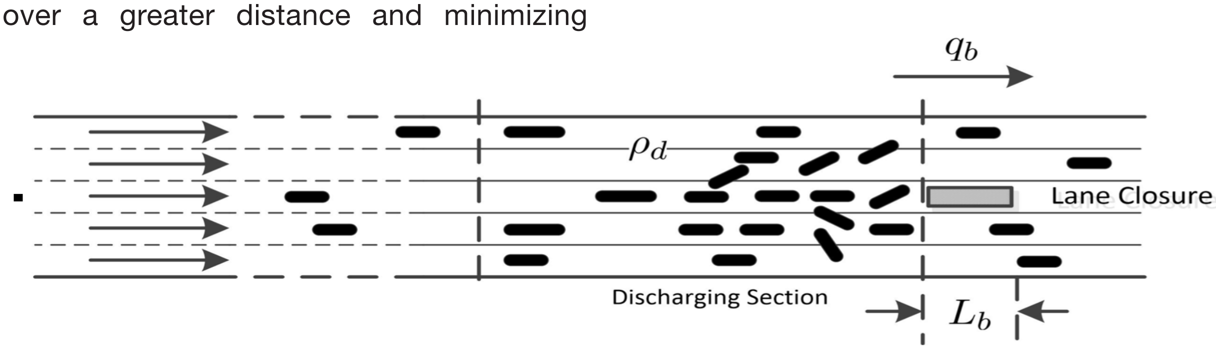

Figure 1. Bottlenecks can occur when vehicles are forced to change lanes at low speeds close to a lane closure.

METRANS Transportation Center USC CSULB

Use of variable speed limits and lane change control can reduce both fuel consumption and emissions. Heavy trucks in particular use considerable fuel while accelerating. Because these systems smooth traffic flow and minimize abrupt stops and starts, they allow trucks to operate more efficiently. Simulations found that a combination of variable speed limits and lane change control could result in fuel savings of about 20% and carbon dioxide and nitrogen oxide emissions reductions of 16%–20%.

Variable speed limits reduce the need for frequent lane changes, potentially improving safety on highways with significant heavy-duty truck travel. Vehicles are less likely to change lanes if each lane has a similar density and speed. Fewer lane changes on truck-dominant highways can improve traffic safety, since trucks need extra time and space to change lanes, and their larger size obstructs drivers' vision during lane changes.

Much of the infrastructure necessary for implementing variable speed limits and lane change control is already in place. As vehicles become more connected and begin to communicate directly with other vehicles and infrastructure, guidance about speed limits and lane changes can be shared immediately with each vehicle. Even without such connected-vehicle technology, these techniques can be deployed without major changes to highway infrastructure. Indeed, speed limit and lane change information is already being communicated on many European highways using existing roadside signs (Figure 2).

More Information

This policy brief is drawn from "Traffic Flow Models and Impact of Combined Lane Change and Speed Limit Control on Environment in Case of High Truck Traffic Volumes," a research report from the National Center for Sustainable Transportation (NCST), authored by Petros Ioannou, Yihang Zhang, and Yanbo Zhao of the University of Southern California. The full report can be found on the NCST website at https://ncst.ucdavis.edu/project/eco-friendly-intelligent-transportation-system-technology-freight-vehicles-0.

This policy brief is also drawn from "Reducing Truck Emissions and Improving Truck Fuel Economy via Intelligent Transportation System Technologies," a research report from the NCST, authored by Petros Ioannou and Yihang Zhang of the University of Southern California. The full report can be found on the NCST website at https://ncst.ucdavis.edu/project/reducing-truck-emissions-and-improving-truck-fuel-economy-its-technologies.

For more information about the findings presented in this brief, please contact Petros Ioannou at ioannou@usc.edu.

Figure 2. An overhead sign communicating variable speed limits on an Austrian highway (www.asfinag.at)

The National Center for Sustainable Transportation is a consortium of leading universities committed to advancing an environmentally sustainable transportation system through cutting-edge research, direct policy engagement, and education of our future leaders. Consortium members: University of California, Davis; University of California, Riverside; University of Southern California; California State University, Long Beach; Georgia Institute of Technology; and the University of Vermont.

Visit us at
ncst.ucdavis.edu

Follow us:

DOI:10.7922/G2GB229Q