

Development of a Tool for Measuring Non-recurrent Congestion Impacts of Accidents (ATMS TESTBED PHASE III FINAL REPORT)

Why Was This Research Undertaken?

Although it has been speculated that non-recurrent congestion caused by accidents, disabled vehicles, spills, weather events, and visual distractions accounts for one-half to three-fourths of the total congestion on metropolitan freeways, there are insufficient data to either confirm or deny this conjecture. When considering the extreme difficulty of estimating accident likelihood due to the definitional properties of non-recurring congestion, the most important potentially soluble factor in the development of accident management strategies is to identify and to quantify the conditions affecting the total delay by accidents.

Most of all the quantification of the total delay by an accident is required as basic information for the purpose of accident management strategies as well as is used as a performance measure to evaluate transportation policies and planning level analyses associated with design of transportation systems or preparation of operating plans for safety. However, in order to collect the real data regarding the total delay, there is a need for a specially designed detection system that detects long freeway sections and records the traffic condition on them for long periods. Thus the objective of this study is to develop temporal and spatial methods to quantify the accident delay as well as to identify the causal factors affecting the total delay caused by accident, based only on loop data.

For more in depth discussion and technical analysis, refer to [TTR3-04 \(Testbed Technical Report\)](#).

What was done?

The objective of this project was to develop and apply an analytic procedure that estimates the amount of traffic congestion (vehicle hours of delay) that is caused by different types of accidents that occur on urban freeways in California. Binary integer programming is applied for estimating temporal and spatial extent of delay caused by freeway accidents. The basic idea to estimate the congested area by an accident originated from the speed difference between under normal flow condition and under accident condition.

Our analysis involved a case study of accidents that occurred on freeways in Orange County in 2001. Two

datasets were combined to accomplish the objective of the study: (1) accident data from the Traffic Accident Surveillance and Analysis System (TASAS), which covers all police-investigated accidents on the California State Highway System, and (2) traffic flow data from the Vehicle Detection System (VDS), received directly from the Caltrans District 12 front-end processor (FEP) using the UCI Testbed Intertie with Caltrans District 12. The non-recurrent delay caused by the case study accidents is estimated based on inferred link speeds derived from loop data and a binary integer programming formulation to identify the temporal and spatial region affected by the accident.

Using non-recurrent delay computed for a sufficient sample of accidents, a statistical model was estimated that describes non-recurrent delay as a function of day of week, time of day, weather, and the observable (e.g., from emergency calls and/or aerial or on-scene observation) characteristics of the accident. These accident characteristics, which are available to Freeway Traffic Management Systems, include time of day, number of involved vehicles, whether a truck is involved, and collision location (by lane or side of road). This statistical model can be used to inform a manager as to the expected delay associated with an accident as soon as the accident is reported and its characteristics are observed. This can in turn be used in improving resource allocation.

Computations of non-recurrent delay were successfully performed for 870 accidents that occurred on weekdays throughout the period of March through December 2001 on the six major Orange County non-toll freeways.

What can be concluded from the Research?

The median total delay for these 870 accidents is 86 vehicle hours, the lower bound of the mean is 184 vehicle hours, and the lower bound of the standard deviation is 246. As indicated by the difference between the median and the high standard deviation relative to the mean, the distribution of non-recurrent delay is highly skewed

to the right (i.e., toward high values of delay), as expected. A regression model was developed that can forecast the expected amount of non-recurrent delay for different types of accidents that occur at different times. Our results indicate that the following accident characteristics are crucial in identifying those accidents that are likely to cause the most delay: (a) how many vehicles are involved in any accident occurring during the weekday AM peak, and whether the accident is in the left lane or not, (b) how many vehicles are involved in an accident occurring in the midday period, and whether there is a truck involved in the accident, (c) which lane a PM peak period accident is located in, and whether or not it is a single-vehicle accident, (d) whether or not a truck is involved in any accident, and finally, (e) whether or not the accident occurs on Friday.

The most important predictor of delay is whether the accident involves two vehicles and occurs in the midday period. This combination indicates an accident that would generally occur in heavy traffic that is moving at relatively high speeds. It would also be an accident that occurs prior to buildup of the afternoon rush hour, so that lingering effects are typically likely to influence steadily increasing levels of traffic. The next most important indicators are whether a PM peak period accident was located in the interior or left lanes, and whether an AM peak period accident involved multiple vehicles.

The accident that is likely to cause the greatest delay is an AM peak period accident involving three or more vehicles, which multiplies the base level of delay by a factor of more than seven. Other indicators of extensive delay is whether a PM peak period accident is in the left lane or off-road left, whether a AM peak period accident involves two-vehicles, or whether a PM peak period accident is in the interior lane(s). Reduced levels of delay are expected for truck-involved accidents and for AM peak-period accidents in the left lane. However, if a truck is involved in an accident that occurs in the midday period (weekdays, 9:01 a.m. through 3:29 p.m.), more non-recurrent delay can be expected. Also, single-vehicle accidents that occur in the PM peak period will lead to more delay, because such accidents are typically more severe (over 30% of PM peak period single-vehicle accidents are injury accidents, compared to about 25% of PM peak period multiple-vehicle accidents).

What do the Researchers recommend?

Eventual application of the results reported here can give managers an estimate of the total non-recurrent delay due to each of these accidents, as soon as they are spotted and basic characteristics are known.

These results can also be useful for the performance evaluation of accident management systems by quantifying accident congestion in terms of

total delay to evaluate the benefit of accident management systems accrued from efficient traffic operations. Additionally, they can be used by public sector transportation. With further testing and refinement, the modeling procedures developed could be incorporated as a layer in the ATMS map display that, once an accident and its essential characteristics are observed, would display the likely spatial and temporal extent of the congestion expected from the accident.

Implementation Strategies

One of the main implementation strategies is to test the model's ability to distinguish locations and conditions with high accident rates from those with low accident rates. Because the methodology does not depend directly on specific geometric characteristics, but rather is based on the traffic conditions arising from both roadway layout and demand, the goal is to demonstrate that the tool can be readily transferred to any urban freeway that is fully instrumented with loop detectors without the need for extensive calibration. Once validated, code will be developed to deploy the model as a stand-alone on the Testbed website using data from the Caltrans District 12 FEP as input. Eventually the tool could provide the safety element of a performance measurement system such as PeMS.

List of Contacts

Principle Investigator:

Dr. Will Recker
Institute of Transportation Studies
University of California; Irvine, CA 92697-3600
Tel.: (949) 824-5642; Fax: (949) 824-8385
Email Address: wwrecker@uci.edu

Other Investigators:

Dr. Tom Golob
Institute of Transportation Studies
University of California, Irvine, CA 92697-3600
Tel.: (949) 824- 6287; Fax: (949) 824-8385
Email Address: tgolob@uci.edu

Contract Manager:

Fred Yazdan
Caltrans, Division of Research and Innovations
Office of Technology Applications
Advanced Testbed Program Branch
6681 Marine Way, Irvine, CA. 92618
Tel.: (949) 936-3462; Fax: (949) 936-3461
Email Address: fred.yazdan@dot.ca.gov