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TECHNICAL SUMMARY

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PROJECT COST:

\$107,000



This project improved guidelines about how lane closures affect highway capacity.

Managing Work Zone Delays by Improved Estimation of Traffic Diversion and Capacity

What Was the Need?

Accurate estimation of delays caused by lane closures on highways is of critical importance for effectively managing traffic flows around work zones.

Current work zone delay models require as inputs the reduced capacity of the work zone and diversion rates at each diversion point. Calculating diversion rates is particularly difficult because while they are a function of delay, delay is in turn affected by the amount of diversion. While large-network planning models have been suggested to address the coupling effects of diversion and delay, those models require extensive data sets that are not always available or accurate on a corridor scale.

A tool that can estimate traffic diversion by explicitly reflecting the interaction between diversion and delay on a corridor level with the currently available data would help MnDOT develop effective work zone management plans, which will reduce road user costs, including driver time lost because of delay.

What Was Our Goal?

The goal of this project was to develop new procedures that can estimate diversion and capacity reduction in work zones on highways.

What Did We Do?

Researchers downloaded traffic data from MnDOT's database for 12 work zones in the metro area between 2009 and 2013. Due to the lack of detectors on some work zone sites, only six sites could be used for diversion rate analysis while all 12 sites were used for capacity analysis. The information researchers collected included:

- Lane configuration changes at each site.
- Traffic flow data upstream and within the work zone on ramps and the mainline. Data from the previous year served as "before" data for comparison.
- Travel time and average speed before and during construction.
- Travel time and length of alternative routes. Researchers developed a process using open-source digital map data and Dijkstra's shortest-path algorithm to identify alternative routes in this study. They also developed a method to access data from MnDOT's [SMART-Signal system](#), which collects traffic and signal data on arterial roads. SMART Signal is currently installed on a relatively small number of arterials, but as its implementation expands, this model will be able to make use of its data.

Using the data, researchers developed a set of models that could explain the interacting relationship among diversion rates, work zone delays and alternative route travel times. After calibrating parameters using data collected from past work zones, they linked the diversion model to a Freeval traffic simulation model in an iterative process. First, they

This project improved methods for estimating reduced traffic capacity and diversion rates due to highway work zones. This information is necessary to help MnDOT effectively manage work zone delays, which will reduce lost time for drivers and road user costs.

“We’re going to need to estimate delay in work zones for as long as I can see, so we wanted a tool we could use to accomplish that task.”

—Tiffany Dagon,
Traffic Work Zone
Engineer, MnDOT Metro
Division

“The process developed in this study can be a practical tool for MnDOT engineers to determine expected diversion rates for given work zones using currently available data in the field.”

—Eil Kwon,
Professor, University
of Minnesota Duluth
Department of Civil
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Estimating the number of vehicles that leave a highway to avoid a work zone is necessary for predicting and managing work zone delays, but existing models were not adequate for calculating the diversion rate accurately.

estimated the delay for a given work zone by assuming no diversion. Then they used that delay in the diversion model to estimate a new diversion rate that could be fed into the delay model. They continued that process until they reached an equilibrium where further iterations did not change the diversion or delay values, which they presented as the expected values for a given work zone.

Researchers also identified the traffic densities that produced the maximum traffic flows in each work zone section studied. By grouping sections with similar characteristics, they developed a process to determine the capacity of other highway sections after lane closures.

What Did We Learn?

Analysis of the traffic diversion patterns at entrance and exit ramps upstream of work zones has allowed researchers to create models that estimate diversion rates based on freeway delay and travel times on alternative routes. The models are used to develop an iterative process to determine both diversion and delay estimates for a given work zone.

Capacity analysis found that the impact of a work zone on road capacity depends on the geometric conditions of a work zone, including factors such as lane closure configuration, lane width and median/shoulder types. By grouping similar sections, researchers developed a table of capacity guidelines for new work zones with similar configurations.

What’s Next?

The traffic diversion estimation process developed in this project has not been implemented yet due to MnDOT staff turnover. Implementing it will be the responsibility of a work zone analysis engineer when the position is filled. At that time, an implementation project to test and streamline the software will be the next step. The chart for traffic capacity in work zones does represent an improvement on the information MnDOT had previously and will be applied on upcoming construction projects.

Most of the work zones examined as part of this project had a two-to-one lane closure configuration. However, MnDOT often has work zones that reduce highways from three lanes to two, so more analysis may be necessary to accurately determine how that configuration will affect diversion rates and road capacity.

This Technical Summary pertains to Report 2016-12, “Development of a Guideline for Work Zone Diversion Rate and Capacity Reduction,” published March 2016. The full report can be accessed at mndot.gov/research/TS/2016/201612.pdf.