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Modeling Merging Behavior at Lane Drops

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Abstract

In work-zone configurations where lane drops are present, merging of traffic at the taper presents an operational concern. In addition, as flow through the work zone is reduced, the relative traffic safety of the work zone is also reduced. Improving work-zone flow-through merge points depends on the behavior of individual drivers. By better understanding driver behavior, traffic control plans, work zone policies, and countermeasures can be better targeted to reinforce desirable lane closure merging behavior, leading to both improved safety and work-zone capacity. The researchers collected data for two work-zone scenarios that included lane drops with one scenario on the Interstate and the other on an urban arterial roadway. The researchers then modeled and calibrated these scenarios in VISSIM using real-world speeds, travel times, queue lengths, and merging behaviors (percentage of vehicles merging upstream and near the merge point). Once built and calibrated, the researchers modeled strategies for various countermeasures in the two work zones. The models were then used to test and evaluate how various merging strategies affect safety and operations at the merge areas in these two work zones.

Keywords

Behavior, Countermeasures, Drivers, Merging control, Traffic control, Traffic flow, Work zone safety, Work zones, driver behavior, microsimulation model, traffic operations, traffic safety measures, Vissim modeling, work-zone capacity, work-zone flow-through, work-zone lane drops, work-zone merging

Disciplines

Civil Engineering

Comments

For the related 51-page full report, please see http://lib.dr.iastate.edu/intrans_reports/

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tech transfer summary

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RESEARCH PROJECT TITLE
Modeling Merging Behavior at Lane Drops

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The mission of the Center for Transportation Research and Education (CTRE) at Iowa State University is to develop and implement innovative methods, materials, and technologies for improving transportation efficiency, safety, reliability, and sustainability while improving the learning environment of students, faculty, and staff in transportation-related fields.

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A better understanding of the merging behavior of drivers will lead to the development of better lane-drop traffic-control plans and strategies, which will provide better guidance to drivers for safer merging.

Background

A large number of lane miles are under construction in the Midwest during the peak summer roadway usage season each year. Coupled with increased seasonal traffic volume, work zones become points of congestion that can lead to driver frustration and aggressive driver behavior.

Problem Statement

In work-zone configurations where lane drops are present, merging of traffic at the taper presents an operational concern. In addition, as flow through the work zone is reduced, the relative traffic safety of the work zone is also reduced. Improving work-zone flow-through merge points depends on the behavior of individual drivers.

Goal and Objectives

The goal of this project was to improve work-zone driver-behavior models, particularly near the merge point. To accomplish this goal, the objectives of this effort were as follows:

- Identify work-zone merge countermeasures appropriate for the Midwest
- Develop and calibrate microsimulation models to better incorporate realistic and accurate driving behavior for merging
- Apply the model for different work-zone plans and countermeasures and determine their impact on driver behavior

Camera view of urban work-zone merge used as part of this research

Research Description/ Methodology

A comprehensive literature review was conducted to summarize information about the effectiveness of work-zone strategies to address merging behavior leading to increased operations and improved safety. The team also conducted a survey of agencies in the Midwest to determine which countermeasures are regularly used as well as which innovative strategies have been considered.

One chapter of the report provides a review of the following strategies, which have been used to encourage desirable lane-merge behaviors to improve traffic flow and safety at work-zone merges:

- Variable speed limits
- Temporary rumble strips
- Static late merge
- Dynamic early-merge and late-merge systems

For each strategy, the information includes background, application (with a focus on information from the Midwest agency survey), effectiveness, advantages, and disadvantages.

Another chapter describes data collection and reduction as well as modeling development and calibration of an urban and an Interstate work-zone microsimulation model in Vissim. The two Iowa work zones, one on Lincoln Way in Ames and the other on I-35 in Hamilton County, were modeled and calibrated in Vissim using real-world speeds, travel times, queue lengths, and merging behaviors (percentage of vehicles merging upstream and near the merge point).

Once built and calibrated, strategies for the various countermeasures were modeled in the work zones. The models were then used to test and evaluate how the various merging strategies affect safety and operations at the merge areas in these work zones.

Late merge signs top and bottom right (Willy Sorenson, Iowa DOT), variable speed limit equipment middle left (Rob Bushman and Rod Klashinsky), dynamic merge equipment middle right (MnDOT Office of Traffic, Safety, and Operations), and temporary rumble strips bottom left (Roads and Bridges)

Key Findings

For the Interstate work zone, the early-merge scenario was found to make speeds more consistent and reduce both queue lengths and queue stops. It made merging smoother than the real-world scenario. It did, however, decrease speeds upstream more and pushed the queue farther away from the merge point. It was modeled based off a perfect scenario where all drivers would merge early, which in real life would most likely not be the case, so results in the real world would not be expected to be as great.

The late-merge scenario also improved operations for the Interstate work zone, by decreasing travel time, queue lengths, and queue stops. Speeds at the merge point were lower than with the real-world scenario, which is a potential safety benefit.

For the urban work zone, only the late-merge scenario was tested. It was found to improve operations by decreasing travel time, and all queue lengths.

The real-world merging behavior for this work zone greatly resembled the early-merge strategy, which saw improved operations compared to the late-merge strategy for the Interstate scenario. This may help to explain the decrease in operations seen with the late-merge strategy at this work zone.

The early-merge strategy was not tested for the urban work zone as the majority of drivers already merged early with none merging within 200 feet of the merge point.

Conclusions

Overall, both the early-merge and late-merge strategies were found to improve operations and to smooth flow at the merge points in the work zone. Queue lengths, which pose safety concerns if they extend too far upstream, because they can surprise drivers who are not expecting or aware of the work zone ahead, were decreased in both situations.

The early merge was found to be a good option when there was moderate congestion as it smoothed speeds and had shorter queues and travel times than the late-merge or real-world options. If vehicles increased, however, this option could extend queues further upstream, which could result in longer queues.

The late-merge option did improve operations over the real-world scenario and may have been a better option if more vehicles were present.

Implementation Benefits and Readiness

Traffic control plans, work-zone policies, and countermeasures can be better targeted to reinforce desirable lane-closure merging behavior, leading to both improved safety and work-zone capacity, by better understanding driver behavior.

Results of this research may be useful to the Smart Work Zone Deployment Initiative (SWZDI) departments of transportation (DOTs)—Iowa, Kansas, Missouri, Nebraska, and Wisconsin)—as well as counties and cities. Some avenues to pursue in sharing the project results are to work with the SWZDI panel (note that SWZDI is a Federal Highway Administration (FHWA) Pooled Fund Study), the Iowa Local Technical Assistance Program (LTAP), and others to conduct further technology transfer of the results.

Selection and appropriate application of strategies will result in better output from work-zone traffic analysis tools. In turn, better output will lead to more-robust estimations of the impacts of a particular work-zone configuration. This will allow more effective and efficient traffic control plans to manage traffic around work zones and adjacent routes.

Improved evaluation of alternatives will ultimately lead to decreased congestion and improved travel time and mobility through work zones, benefiting agencies, workers, and the traveling public.