Traffic Impact Assessment of Moving Work Zone Operations

tech transfer summary

Guidance on assessing the traffic impacts of moving work zones can help practitioners improve scheduling and mitigate the work zone's impacts on traffic flow and safety.

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MTC RESEARCH PROJECT TITLES
Traffic Impact Assessment of Moving Work Zone Operations

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Smart Work Zone Deployment Initiative
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The Midwest Transportation Center (MTC) is a regional University Transportation Center (UTC). Iowa State University, through its Institute for Transportation (InTrans), is the MTC lead institution.

MTC's research focus area is State of Good Repair, a key program under the 2012 federal transportation bill, the Moving Ahead for Progress in the 21st Century Act (MAP-21). MTC research focuses on data-driven performance measures of transportation infrastructure, traffic safety, and project construction.

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Objective

The objective of this research project was to develop guidance for practitioners on assessing the traffic impacts of moving work zones.

Background

Highway maintenance work involves both short-term stationary work zones and moving work zones (MWZs), with MWZs typically used for striping, sweeping, pothole filling, shoulder repair, and other quick maintenance activities.

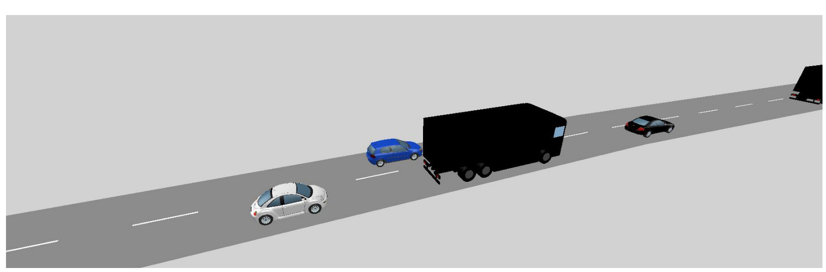
Both types of work zones create adverse operational and safety impacts, which state departments of transportation (DOTs) strive to mitigate through strategic scheduling, traffic management plans, and innovative use of available technologies.

Problem Statement

Because MWZs create a different type of bottleneck than stationary work zones, existing traffic impact analysis tools are not designed to model the impacts of MWZs. Additionally, many existing studies of moving bottlenecks are theoretical in nature, limited to certain lane configurations, and restrictive in the types of mobile work zone attributes considered. Driver behavior at moving bottlenecks is also not well understood and has not been investigated in prior research, in part due to the challenges with data collection at MWZs.

Research Description

Two approaches were used to assess the traffic impacts of MWZs. Only MWZs with slow moving work trucks in a single travel lane were investigated. First, real-world data were used to calibrate VISSIM simulations that were, in turn, used to analyze the traffic impacts of MWZs. Second, a data-driven approach was used to develop regression models of work zone speeds as a function of various independent variables, including work zone characteristics and schedules and traffic and geometric characteristics.



Slow-moving truck in a VISSIM simulation

Four data sources were used to determine the VISSIM calibration values and develop the regression models:

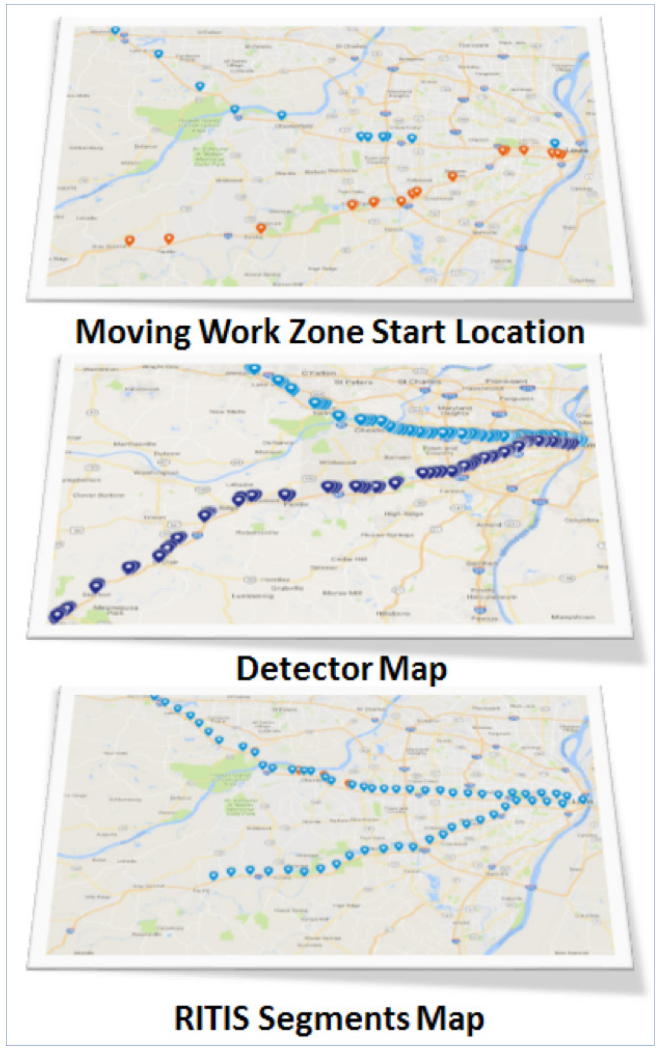
- Missouri DOT (MoDOT) electronic alerts (e-alerts) provided information on MWZ locations, start/end dates and times, and lane closures.
- The Regional Integrated Transportation Information System (RITIS), an automated data sharing, archiving, and dissemination platform operated by the Center for Advanced Transportation Technology Laboratory at the University of Maryland, provided travel time and speed data and information on roadway segments.
- MoDOT traffic flow detectors provided data on vehicle spot speeds and traffic volumes.
- Field videos of MWZs recorded from the back of a truck-mounted attenuator (TMA) were processed using photogrammetry to provide information on driving behavior around the MWZs. Information included the distance from the back of the truck to the location at which the following vehicles merged into the adjacent open lane, the gaps available in the open lane for each lane-changing vehicle, the speeds of the work truck and the vehicles that passed the work truck, and other information.

A total of 30 MWZs active between July 2014 and July 2015 on the I-44 and I-64 freeways in the St. Louis, Missouri area were identified for analysis.

The speed distributions obtained from the detector data and the lane change information obtained from the MWZ videos were used to calibrate VISSIM to simulate MWZs. Two categories of VISSIM driving behavior parameters—car-following and lane-changing—were tested and modified.

The calibrated parameters were then applied in VISSIM to simulate the impacts of MWZs of different durations and lengths. An 18-mile segment of a three-lane urban freeway was used as the test network. The simulation was run for five different durations (15 minutes to 2 hours) and five different volumes (350 to 1,800 vehicles).

Still capture from a MWZ camera video



Google Maps 2017

MWZ start locations, detector locations, and RITIS segments

The safety impacts of MWZs, including both rear-end and lane-change conflicts, were assessed using vehicle trajectory plots from the simulations and the Surrogate Safety Assessment Model (SSAM). Tradeoff plots between the number of conflicts and combinations of activity duration and traffic volume were also generated.

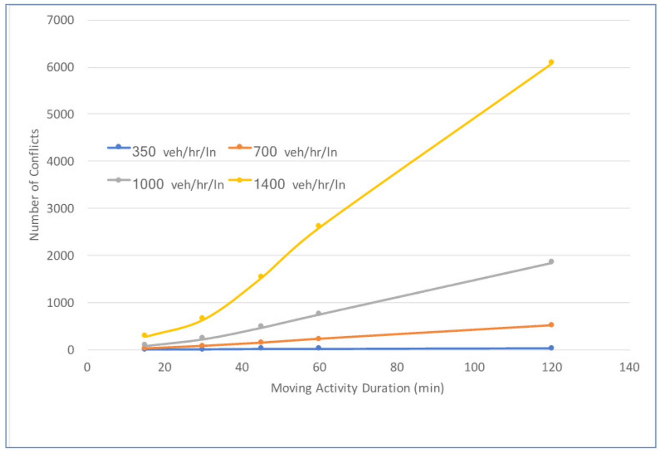
Information from the RITIS and the MoDOT e-alerts were used to develop a linear regression model for predicting traffic speeds in MWZs. Independent variables included speed limit (SpL), historical speed (HiSp), number of lanes (NoL), segment traffic volume (Vol), duration (Dur), MWZ position (LR), and time (DN).

Key Findings

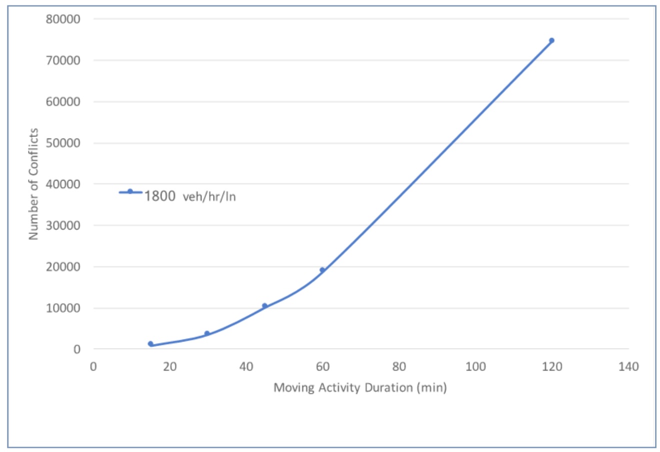
- The calibrated car-following and lane-changing parameters yielded VISSIM simulation results that were more consistent with the driving behaviors observed in the MWZ videos than the results generated by the VISSIM default parameters.
- The results of the simulations showed that moving work zones led to increased delays, queuing, and stops. These impacts increased as the traffic volume and MWZ duration increased.
- As volumes approach 1,800 vehicles/hour/lane, even a 30-minute activity can generate a 3.2-mile-long queue, which increases to 6.5 miles for a 60-minute activity and 13 miles for a 120-minute activity.
- The impacts of work zone duration on the number of conflicts increased as traffic volumes exceeded 700 vehicles/hour/lane. The results show a near-linear increase in the number of conflicts with duration until the volume reaches 1,800 vehicles/hour/lane, after which the increase becomes non-linear.
- The number of conflicts sharply increased when the duration of the work zone activity was greater than 60 minutes and when the traffic volume was 1,800 vehicles/hour/lane, indicating that moving activities lasting longer than 1 hour on a freeway with a volume of 1,800 vehicles/hour/lane or higher will result in significant negative safety impacts.
- The best linear regression model for predicting traffic speeds in MWZs was found to be $WZSp = -26.738 + 0.962 \times SpL + 0.345 \times HiSp + 2.015 \times NoL - 10.184 \times LR - 5.607 \times DN$

Conclusions and Recommendations

- The three recommended VISSIM calibration parameters are a safety reduction factor of 0.7, a minimum look ahead distance of 500 ft, and the use of VISSIM's smooth closeup option.
- A moving work activity lasting one hour or more is best scheduled for times when the traffic volume is under 1,400 vehicles/hour/lane, and preferably under 1,000 vehicles/hour/lane.
- Scheduling shorter duration moving activities on high-volume roads at multiple times (on the same day or on different days) is preferable to scheduling a single longer duration activity.
- If a moving activity must be scheduled during higher volume conditions (1,000 vehicles/hour/lane or more), a shorter duration (i.e., 60 minutes or less) would work best to avoid significant negative safety impacts.



Conflicts versus moving activity duration for traffic volumes less than 1,800 vehicles/hour/lane



Conflicts versus moving activity duration for a traffic volume of 1,800 vehicles/hour/lane

Implementation Readiness and Benefits

While simulating a moving work zone is more difficult than simulating a stationary work zone, the recommended VISSIM calibration parameters can help practitioners successfully simulate MWZs in VISSIM.

DOTs can use the tradeoff plots between conflicts, activity duration, and traffic volume generated in this study to determine, for example, whether to conduct a moving work activity for a short duration when the traffic volume is high or for a longer duration when the volume is lower.

The guidance provided in this study on assessing the traffic impacts of moving work zones can help practitioners improve scheduling and mitigate the work zone's impacts on traffic flow and safety.