SWZDI
Smart Work Zone Deployment Initiative

Mobility and Safety Impacts of Work Zone Lane and Shoulder Widths

tech transfer summary

Understanding and quantifying the mobility and safety impacts of lane and shoulder widths is vital for designing work zones.

Goal

The goal of this project was to quantify the mobility and safety impacts of different combinations of lane width and shy distance to a barrier for a given paved roadway width.

Background and Problem Statement

Work zones must be designed within a given paved width, especially when traffic is crossed over into the opposing lanes and the traffic flow is counter-directional. Designers face the challenge of understanding the safety and mobility implications of the allocation of lanes and shoulders/shy distances (the distances to adjacent barriers) for a given paved width.

For example, given an available paved width of 26 ft, would it be better to create two 12 ft lanes with 1 ft shy distances or two 11 ft lanes with 2 ft shy distances? Narrower lanes would reduce speeds, which could reduce crash severity were a crash to occur. However, narrower lanes could increase crash frequency, and reduced speeds could decrease capacity and increase the likelihood of back-of-queue crashes.

The safety and mobility impacts of combinations of lane widths and shy distances in work zones have not been evaluated.

Vehicles passing through a work zone with two open lanes bounded by concrete barriers

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RESEARCH PROJECT TITLE
Mobility and Safety Impacts of Work Zone Lane and Shoulder Widths

SPONSORS
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The Smart Work Zone Deployment Initiative (SWZDI) is a transportation pooled fund that supports research investigations into better ways to improve the safety and efficiency of traffic operations and highway work in work zones. The primary objective is to promote and support research and outreach activities that focus on innovative policies, processes, tools, and products that enhance the implementation, safety, and mobility impacts of work zones. The fund is administered by Iowa State University's Institute for Transportation, and the lead agency is the Iowa Department of Transportation.

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Research Description

The data for the analyses were collected at 17 work zone locations in Illinois, Michigan, and Wisconsin. All locations had two open lanes in each direction in the work zone and concrete barriers on both sides. The lane widths were 11 or 12 ft, while shy distances to the barrier ranged from 1 to 3 ft. At each location, information on speed limit, enforcement or speed management strategies, and any other factors that could impact speed or lane position were noted.

The lateral position of vehicles in the right travel lane was used as a surrogate safety measure to understand the safety impacts of lane width and shy distance. To measure lateral distance, the research team developed a data collection device using two directional lidar sensors with update rates of 1,000 Hz (one reading every millisecond). The data were used to derive vehicle speed, vehicle length/type, and headway information under daytime and nighttime conditions.

Lateral distance data from over 250,000 vehicles were used for the safety analysis. Because the data collection device could only be mounted on the right concrete barrier due to safety concerns, the safety analysis only considered right side departures for vehicles in the right lane.

Linear regression was used to model the average lateral distance of all vehicles and vehicles in the lowest one percentile of the lateral distance observations (tail vehicles). Extreme value theory (EVT) modeling was conducted to estimate the probabilities of right edge line encroachment and right barrier contact.

The speeds of over 125,000 free flow vehicles were used to quantify the mobility impacts of lane width and shy distance. Unlike the safety analysis, the mobility analysis considered vehicles in both lanes. Linear regression modeling was used to develop two models for estimating free flow speeds in work zones based on geometric and operational variables.

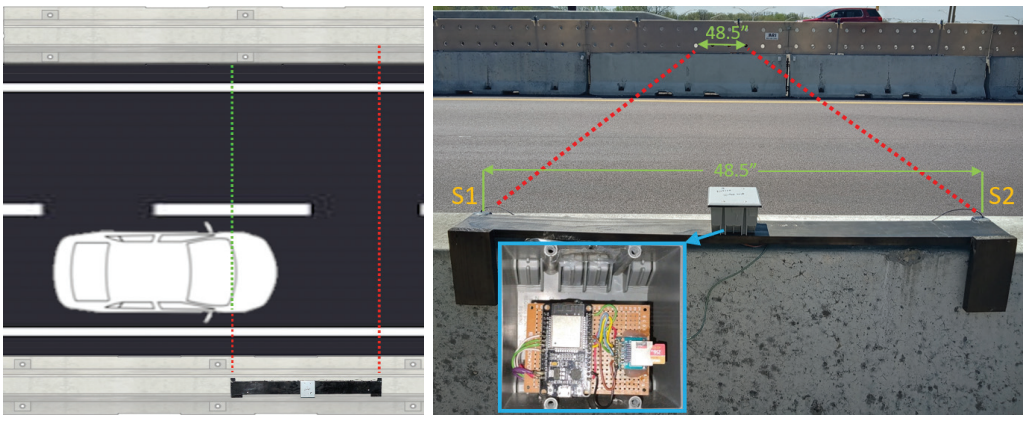
Key Findings

Safety

- Lane width and shy distance significantly influenced the lateral position of vehicles relative to the edge line and barrier. Additionally, lateral distance to the edge line and barrier increased during nighttime compared to daytime.
- All vehicles and tail vehicles tended to move farther from the edge line and the barrier on 12 ft lanes compared to 11 ft lanes. All vehicles and tail vehicles tended to gravitate closer to the edge line but farther from the barrier with larger shy distances (3 ft compared to 2 ft and 1 ft).
- Narrower lanes contributed to an increased probability of edge line encroachment and barrier contact, while wider shy distances were associated with an increased probability of edge line encroachment and a reduced probability of barrier contact.

Mobility

- Free flow speeds were generally higher in the left lane, though three locations had higher speeds in the right lane.
- Eleven of the 17 sites showed statistically significant higher speeds during nighttime compared to daytime. In Wisconsin, lighting was present at the locations with higher nighttime speeds. However, a similar correlation between lighting and higher nighttime speeds was not found for the Illinois and Michigan locations.
- Both linear regression models indicated similar trends regarding the impacts of the various variables. Free flow speed increased with an increase in speed limit, lane width, and left/right shy distance to the barrier. Free flow speeds at night were higher than those during the day, and the presence of a speed feedback sign reduced free flow speeds. Compared to Wisconsin, speeds were higher in Michigan and even higher in Illinois.



Schematic diagram and photograph of the data collection device in a work zone

Limitations and Future Research

The primary limitations of this study were as follows:

- The safety analysis only considered right-side departures of vehicles in the right lane.
- Only four locations had a 1 ft shy distance, and all were very short sections (a few hundred feet).
- A more uniform distribution of work zone speed limits across the different states would have been preferred.
- Only one location had a speed feedback sign.

Future research efforts should embark on a larger data collection effort to capture greater variability in the different parameters and to obtain lateral distance data from both the left and right sides to estimate lane departures in both directions and for vehicles in both lanes.

Implementation Readiness and Benefits

This research successfully demonstrated how lateral distance and speed data can be measured and modeled in work zones. This research also quantified the impacts of different lane width and shy distance combinations.

Future research can use this methodology to validate these findings. An Excel spreadsheet tool was developed to quantify the mobility and safety impacts of the different combinations of lane width and shy distance to barrier for a given paved width.