U.S.Department of Transportation
Federal Highway Administration
Office of Operations
Research and Development

FEDERAL HIGHWAY ADMINISTRATION (FHWA) WORK ZONE DRIVER MODEL - VERSION 1.1

This fact sheet describes the development of a specialized driver model and software for work zones – the FHWA Work Zone Driver Model v1.1.

INTRODUCTION

The FHWA Work Zone Driver Model v1.1 was created for planners and engineers, so they can more accurately predict the operational impacts of freeway work zones, such as queues, travel times, and delays. The software interfaces with commercially available microsimulation tools and alters car-following algorithms—derived from empirically collected data—to more accurately match behaviors observed in freeway work zones. The software is available for download on the Open Source Application Development Portal (OSADP)[1] as part of the FHWA Driver Model Platform v0.6.[2]

BACKGROUND

Freeway work zones can have significant operational impacts, accounting for nearly 24 percent of the annual non-recurring delay in the United States.[3] With many freeway segments reaching (and surpassing) their 50-year design life, the number of freeway work zones in the United States is projected to increase. So they can design and plan work zones that minimize delays, planners and engineers need accurate simulation tools to predict the operational impacts of work zones.

Microsimulation has the potential to accurately predict work zone impacts, because it models individual vehicle movements at the trajectory level. Existing microsimulation software packages, however, are not equipped to simulate freeway work zones, because their algorithms do not account for changes in car-following behavior (e.g., acceleration patterns) known to exist as drivers approach and traverse freeway work zones. Before practitioners can accurately predict work zone impacts using microsimulation, a microscopic work zone driver behavior model is required.

CREATING THE MODEL

The model was developed and calibrated using work zone car-following data collected with an instrumented research vehicle (IRV) through freeway work zones on I–95 near Washington, DC in 2013[4] and on I–91 in Springfield, MA in 2016. Tools were developed to identify and classify car-following instances, filtering and processing data so it could be used to describe car-following for passenger cars traversing freeway segments, advanced warning, taper zones, and work zones. These processed data sets will be available on the Research Data Exchange (RDE).[5]

After analyzing the processed data, strong variations in car-following behaviors were observed between work zone and non-work zone segments.[6] Based on these findings, a car-following model was created that reproduces the unique acceleration patterns, headways, and traveling speeds observed for each segment. The resulting work zone car-following model uses a multi-dimensional psycho-physical framework and acceleration/deceleration algorithms derived from modified field theory to describe car-following for freeways, advanced warning, taper zones, and work zones separately.[7,8]

Figure 1. Instrumented research vehicle (IRV) used for data collection.[4]

FHWA WORK ZONE DRIVER MODEL

FHWA and the U.S. Department of Transportation (USDOT) Volpe Center developed a work zone car-following model and DLL file that interfaces with existing microsimulation tools, enabling more accurate simulation of car-following through freeway work zones. The purpose of this project is to provide practitioners at transportation agencies and in private industry with a tool that can better predict the operational impacts of freeway work zones.

Through a technique known as cross-validation, the microscopic models were trained and tested against separate validation data from I–95, ensuring that the acceleration and deceleration behavior were accurate and not over-fit to the empirical data. The software was developed, interfaced with VISSIM, and tested along freeway work zones in Massachusetts.

For more information, please contact: Andrew.Berthaume@dot.gov

VALIDATING THE MODEL

CASE STUDY ON I–91 IN SPRINGFIELD, MA[9]

The Volpe Center worked with MassDOT to test and validate the work zone software against field data collected for the I–91 work zone in Springfield, MA. Performance measures were selected based on how State agencies currently analyze work zone traffic management plans (i.e., location and length of queues and travel times). Field data provided by MassDOT supplement the data collected with the IRV.

RESULTS

The FHWA Work Zone Driver Model predicted travel times and queue locations more accurately than the calibrated microsimulation software package using suggested model parameters. Opportunities to improve the work zone software were noted, including algorithms to reproduce additional variations in driver behavior, currently simulated through microsimulation models' stochastic elements and random number generators.

NEXT STEPS

The FHWA Work Zone Driver Model v1.1 is now available as part of the FHWA Driver Model Platform v0.6[2] (available for download on the OSADP[1]). The model is being continually upgraded; new versions will be released annually.

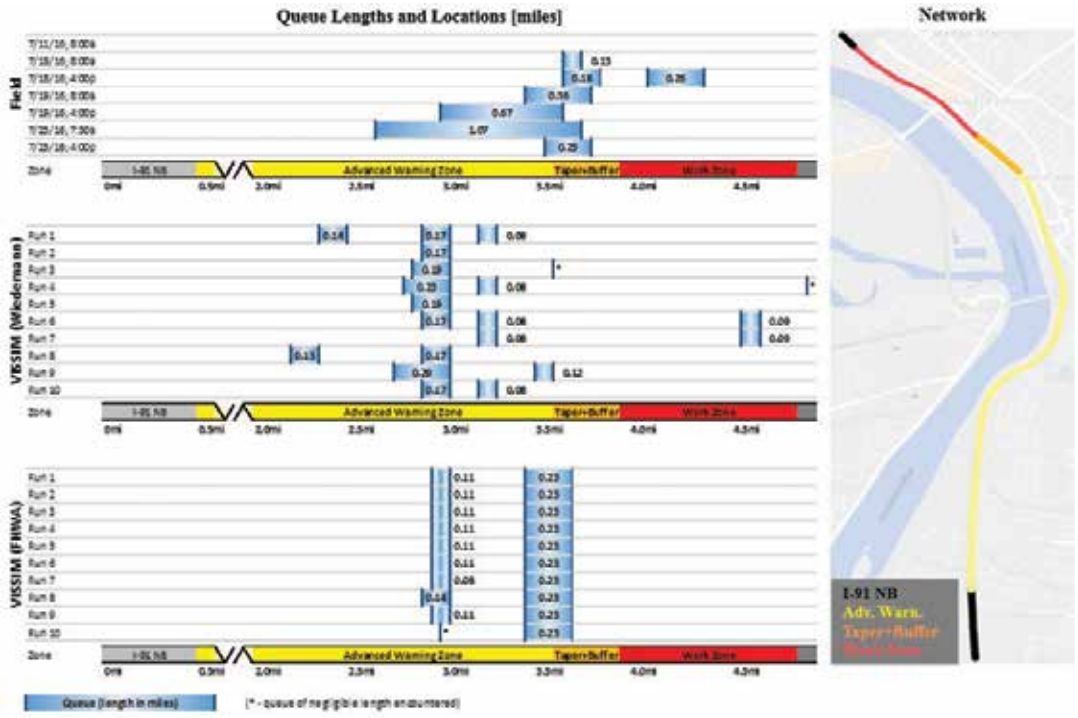

Figure 2. Queue locations and lengths for the I-91 work zone, as observed in the field (top), as predicted by VISSIM (middle), and as predicted by the FHWA Work Zone Driver Model (bottom)[9]

REFERENCES

1. FHWA. "Open-Source Application Development Portal (OSADP)" (website). Washington, DC. Available online: https://www.itsforge.net/, last accessed October 20, 2017.

2. FHWA TechBrief (2018). "Federal Highway Administration (FHWA) Work Zone Driver Model – Version 0.6". In production.

3. FHWA. "Facts and Statistics – Work Zone Mobility." (website). Available online: https://ops.fhwa.dot.gov/wz/resources/facts_stats/mobility.htm, last accessed October 20, 2017.

4. Lochrane, et al. "Understanding Driver Behavior in Work Zones", Public Roads, vol. 76, no. 5, March/April 2013.

5. FHWA. "Research Data Exchange" (website). Washington, DC. Available online: https://www.its-rde.net, last accessed October 20, 2017.

6. Berthaume, et al. (2017) "Variations in Driver Behavior: An Analysis of Car-Following Behavior Heterogeneity as a Function of Road Type and Traffic Condition." Submitted to the January 2018 TRB (paper 18-06005).

7. Lochrane. (2014). "A New Multidimensional Psycho-Physical Framework for Modeling Car-Following in a Freeway Work Zone", PhD diss., University of Central Florida.

8. Berthaume. (2015). "Microscopic Modeling of Driver Behavior Based on Modified Field Theory for Work Zone Application", PhD diss., University of Massachusetts.

9. Berthaume, et al. (2017) "Validating the Performance of the FHWA Work Zone Model Version 1.0 in VISSIM: A Case Study Along I-91 in Springfield, Massachusetts." Submitted to the January 2018 TRB (paper 18-05790).

For more information, please contact:Andrew.Berthaume@dot.gov

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