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RESEARCH SUMMARY

# Optimization of Work Zone Decisions through Simulation

## Problem

Highway maintenance, especially pavement rehabilitation or resurfacing, requires lane closures, which can greatly affect traffic performance and traffic safety due to the reduction in vehicle capacity. Good decisions on work zone characteristics, such as the number of closed lanes, work schedule, work zone configuration, work rate and traffic control strategy, can significantly increase efficiency and safety as well as decrease the negative impacts of traffic disruption.

## Objective

The objective of this research was to develop a comprehensive work zone evaluation and decision support tool for highway maintenance planning and traffic management plan development. This tool may be used to evaluate different work zone plans as well as to optimize various decisions on work zones characteristics and traffic control plans in order to minimize the combined total costs for highway agencies and users.

## Description

In the first part of this study, a work zone cost model was developed based on three approaches: (1) an analytic method for steady traffic inflows; (2) an analytic method for time-dependent traffic inflows; and (3) a simulation method, which uses CORSIM (which is short for “Corridor Simulation”), a widely-used simulation program, to evaluate work zone conditions in a user-defined roadway network. From case studies, we find that CORSIM estimates higher delays than the analytic methods under uncongested traffic conditions and lower delays than the analytic methods under congested conditions. This can be explained by the inability of CORSIM to calculate the delays of the vehicles that cannot enter the network as the queues spill back beyond traffic entry nodes in an over-saturated road network.

In the second part of this study, work zone optimization models were developed based on the above three methods. When using the analytic method for steady traffic inflows, a closed-form formulation of the total cost can be obtained. Classic optimization methods using differential calculus were then applied to identify the preferred solutions.

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When the analytic method for time-dependent traffic inflows or the simulation method is applied, we have no simple expressions for the objective function in terms of the decision variables. Therefore, a heuristic optimization algorithm, named two-stage modified simulated annealing (2SA), was developed to search through the solution space for an optimized solution.

Optimization models based on the analytic method for time-dependent traffic inflows (A2SA) or the simulation method (S2SA) were proposed and tested through numerical examples. In order to reduce the computation time while maintaining a desirable precision level, a hybrid approach (H2SA), was proposed. In the two stages of the optimization algorithm, the analytic method was applied in the Initial Optimization step and the simulation method was used in the second Refined Optimization step. The numerical experiment shows that H2SA can obtain optimized results close to those of S2SA.

## Results

A software package incorporating proposed analysis methods was developed and a users' guide for the software package was provided in the appendix of the final report. Since two analytic methods and a simulation method were developed in this study to estimate the costs with different work zone characteristics for the work zone plan evaluation and optimization, users may choose to use the analytic methods or the simulation method, depending on the availability of data, the level of detail desired for the analysis and the allowable running time.

## Report Information

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