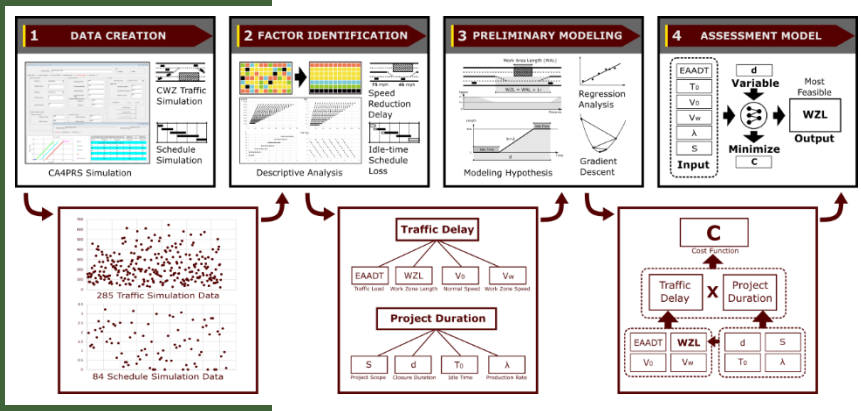
Selecting the Most Feasible Construction Phasing Plans for Urban Highway Rehabilitation Projects

Determine the most feasible work zone length (WZL) to minimize traffic inconvenience while ensuring on-time completion of the project



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Work zone length (WZL) of a highway rehabilitation project is the length of the highway section being closed to public traffic and under construction during each construction window. This study aims to develop a quantitative method to determine a feasible construction phasing plan that can find a WZL to minimize the overall traffic congestions for urban highway rehabilitation projects. To determine a holistic quantiative model that determine the optimal WZL, this study identifies critical factors affecting WZL and develops decision support models that balances tradeoff between motorists' inconvenience due to traffic disruption and their opportunity cost. A high-confidence dataset was created by conducting a series of scheduling and traffic simulations ana analyses. The results revealed that traffic loading and work zone duration are critical factors affecting WZL. Furthur more, the decision support model developed in this study will help state transportation agencies devise better-informed phasing in a viable way to minimize traffic disruptions during construction.

Background

During construction, traffic and construction work co-exist in close proximity. A construction work zone (CWZ) typically will close lanes or reduce lane width, reducing the traffic capacity and speed limits of the constructed highway section, leading to traffic congestions and extra fuel consumption. In practice, such construction phasing plans are typically developed by estimating and comparing road user cost (RUC) for project alternatives under consideration. However, when a phasing plan is poorly conceived, it can cause significant traffic inconvenience, resulting in excessive RUC for the traveling public. An overly long WZL will cause severe traffic congestions. Simultaneously, a WZL that is too short will make the construction process inefficient, increasing the overall time needed to complete the project, thus causing more traffic congestions throughout the entire duration of the project. In short, assessments of construction phasing plans are critical, but they are also difficult to perform.

Project Summary

The main objective of this study is to develop a practical and easy-to-use toolkit to assist STAs improve construction phasing plans of CWZs. The specific objectives of this study were twofold:

a) identify critical factors affecting decisions related to lane closure length in rural highway rehabilitation projects and

b) develop a novel decision support model for determining the optimal work zone length (WZL), accounting for all critical factors.

This research will greatly benefit STAs and the traveling public by significantly improving mobility around the CWZs and positively affecting regional development.

Status Update

Two hundred eighty-five traffic data points (Figure 1) and 84 schedule data points (Figure 2) were generated through traffic and scheduling simulations of the Constructability Analysis for Pavement Rehabilitation Strategies (CA4PRS) software. With these high-confidence data, two preliminary WZL models were developed to estimate the traffic impact and schedule effects of various phasing plans with different WZLs .

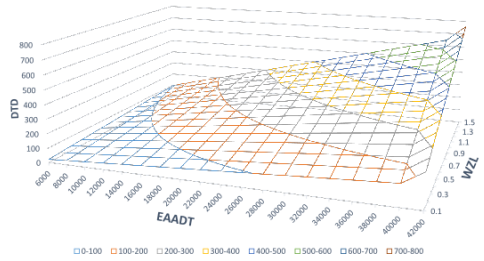
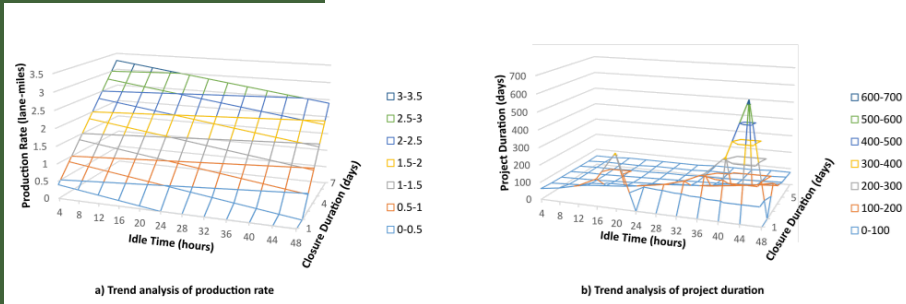


Figure 1. CA4PRS traffic simulation results.



a) Trend analysis of production rate

b) Trend analysis of project duration

Figure 2. CA4PRS schedule simulation results.

After conducting a series of stochastic gradient descent regression analysis, the most feasible phasing plan of a typical two-by-two urban highway rehabilitation project was found (Figure 3).

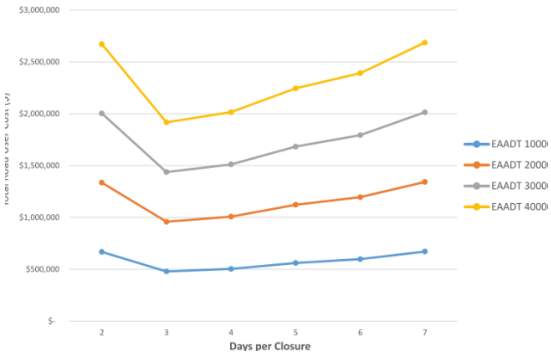


Figure 3. The relationship between phasing plan (days per closure) and total road user costs from traffic delays.

Impacts

Based on the descriptive factor analysis, a critical benchmarking point of traffic load at 41,000 equivalent-cars-per-day was discovered. A series of statistical analyses further validated that the level of traffic disruption was affected by WZL, construction idle time, closure duration, and traffic loading in rural corridors where the EAADT was lower than 40,000 vpd.

The results of the final decision-support model supports the existence of the tradeoff relationship between the traffic impact and project constructability and found the optimal point for all EAADT and idle time range within the scope of a rural highway CWZ. With the assistance of the two provided tables, agency engineers can easily find the most feasible WZL and phasing plan that suits the challenge the project team is facing by finding the matching EAADT (calculated with AADT and truck percentage) and estimated construction idle time.

This study is the first of its kind and will help STAs make better-informed decisions by providing a point of reference when establishing WZL in construction phasing plans. Use of the models will facilitate a more realistic determination of WZL.

Tran-SET

Tran-SET is Region 6's University Transportation Center. It is a collaborative partnership between 11 institutions (see below) across 5 states (AR, LA, NM, OK, and TX). Tran-SET is led by Louisiana State University. It was established in late November 2016 "to address the accelerated deterioration of transportation infrastructure through the development, evaluation, and implementation of cutting-edge technologies, novel materials, and innovative construction management processes".

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