Project Title:
Speed Selection Behavior during Winter Road Conditions

University:
University of Wyoming

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Research Needs:
Adverse weather increases driving risks as roadway conditions become more hazardous, leading to higher crash frequencies (Thakuriah & Tilahun, 2013; Young et al., 2013). On Wyoming interstates, winter season crashes can be 2 to 3 times the frequency of summer season crashes, depending on the severity of the winter season (Young et al., 2013). Most accidents that occur in the winter season are linked to driving too fast for the conditions (Placer, 2001). As road conditions worsen during winter storm events, drivers react differently to the conditions depending on their past experiences with winter conditions and the type of vehicle they are driving. Differences in individual speed selection during adverse conditions lead to increases in speed variation, which has been linked to increased crash risk (Garber & Gadiraju, 1988; Solomon, 1964).

Intelligent transportation system applications related to weather conditions have been viewed as a promising mitigation tool to address road weather safety and operational challenges (Federal Highway Administration, 2013) but effective weather responsive management strategies rely on an understanding of the relationship between weather and traffic parameters as well as the relationship between weather conditions and driver behavior (Gopalakrishna et al., 2011; Young et al., 2013). Previous research has shown the link between weather conditions and the demand of travel, the level of non-recurring congestion, and safety (Thakuriah & Tilahun, 2013). The research proposed addresses the knowledge gap in defining the relationship between weather conditions, traffic speed, and driver behavior during adverse
winter weather conditions in order to improve the effectiveness of weather responsive traffic management strategies.

In a 2011 Federal Highway Administration workshop report, one of the final recommendations made was to continue and expand research on the impact prediction, simulation and decision support for weather responsive traffic management strategies (Gopalakrishna et al., 2011). Earlier research on Variable Speed Limits in Wyoming looked extensively at the development of operation strategies, the impact of weather on observed speeds, and the impact of variable speed limits on speed and safety (Young et al.; Buddemeyer et al., 2010). From this research, future research was identified to research the underlying complexity of speed selection behavior during winter road conditions, to determine what appropriate targets for speed compliance and speed variation are during winter events, and lastly, what are the implications of different speed behaviors on the operation of the system. To address these questions, a larger variety of roadway segments need to be studied and more analysis on the variables explaining the speed behavior need to be performed.

This study proposes to build on the work done on the four interstate variable speed limit corridors from the previous research and add additional rural interstate corridors also subject to frequent adverse winter weather conditions to investigate the questions described above. The research also proposes to use the results from observations and estimated models to provide recommendations on the use of traffic simulation tools to analyze weather responsive traffic management strategies. Lastly, the study will provide guidance on what speed compliance and speed variation targets would be appropriate for the analyzing the success of these weather responsive traffic management strategies.

**Research Objectives:**
The research proposed addresses the knowledge gap in defining the relationship between weather conditions, traffic speed, and driver behavior during adverse winter weather conditions in order to improve the effectiveness of weather responsive traffic management strategies. In particular, the research will be used to provide guidance on selecting target speed compliance and speed variation rates to define success for a weather responsive traffic management strategy.

**Research Methods:**
The first step in analyzing the relationship between speed behavior and weather conditions, observed speeds and weather conditions will be modeled on different rural interstate corridors in Wyoming and Colorado using a methodology developed during previous variable speed limit research in Wyoming (Young et al.; Buddemeyer et al., 2010). Corridors for analysis will be selected from Wyoming and Colorado to provide a broad range of traffic volumes and truck
percentages but with common features such as roadway segments outside urban areas and subject to frequent, adverse winter conditions. Traffic parameters such as speed, speed variation, speed compliance, and vehicle headways will be modeled along with weather variable to determine the statistically significant relationships.

To utilize traffic simulation models to estimate the effectiveness of different weather-responsive traffic management strategies, the software must first be calibrated to be sensitive to the different weather conditions. An early study using the CORSIM simulation package was performed to test the sensitivity of different simulation parameters to modeling weather effects and found the car following, lane changing, and free-flow speed parameters for roadway segments to have medium-to-high sensitivity on various measures of effectiveness (Zhang et al., 2004). While this study did not attempt to calibrate any of the identified of parameters using empirical data but the report does provide guidance on a procedure to do so. A European study did calibrate VISSIM parameters to adverse weather conditions but focused on signalized intersection facilities (Asamer, van Zuylen, & Heilmann). These studies provide guidance on a calibration procedure for this study.

**Expected Outcomes:**
The outcome of the project will be guidance on the use of traffic simulations tools to analyze weather responsive traffic management strategies and recommended targets for speed compliance and speed variation of rural interstate facilities during adverse winter weather conditions. Better understanding of speed behavior during winter conditions is also an expected outcome.

**Relevance to Strategic Goals:**
The primary focus area for this research is Rural Transportation Operations. The research also addresses issues relating to Heavy Vehicles and Commercial Trucks and Freight Security since the interstate corridors studied are major freight corridors with 25 to 70% freight vehicles that incur large losses due to reduced safety and road closures.

**Educational Benefits:**
A case study for use in graduate level courses on the topic of Traffic Simulations would be developed from the study.

**Work Plan:**
The methodology for meeting the research objective stated above is broken down in to the following tasks:
1. Identify interstate corridors in Wyoming and Colorado to be added to the four existing Wyoming Interstate-80 corridors. Eight to 10 corridors covering a range of traffic volumes and heavy vehicle percentages will be selected.

2. Compile speed and weather data for the study corridors for 3-6 storm events per corridor. Storm event periods will include the ideal condition period before and after each winter storm.

3. Run statistical analyses of observed traffic parameters on weather explanatory variables and corridor variables for non-weather conditions such as roadway geometry, truck percentages, and interchange ramp density.

4. Summarize relationships from statistical modeling of observed speed and headway variables versus observed weather variables.

5. Develop VISSIM models of the study corridors under ideal conditions and verify performance of base models.

6. Adjust model parameters of base model to calibrate models for different adverse weather conditions. Use observed data during winter events to calibrate.

7. Develop recommended procedures for calibration of rural interstate facilities during adverse winter weather.

8. Use calibrated models to run tests on different weather responsive management strategies to verify sensitivity of the models to these strategies.

9. Use calibrated models and observed traffic parameters during adverse weather to recommend target values for speed compliance and speed variation during adverse conditions.

10. Report findings in a final report and disseminate information through journal articles and conference presentations.

Project Cost:

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Source of Matching Funds: University of Wyoming match of faculty salary and/or teaching assistantships
TRB Keywords:
Speed, Weather, Variable Speed Limits, Traffic Simulations

References:

Bibliography