

MPC-519

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Project Title:

Operational and Safety Analysis with Mitigation Strategies for Freeway Truck Traffic in WY

University:

University of Wyoming

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Research Needs:

The State of Wyoming road network is characterized by heavy truck traffic. In 2015, truck traffic comprised approximately 22% of Vehicle Miles Traveled (VMTs) along all routes in WY, according to the WYDOT Annual Traffic Report. The heaviest truck traffic exists along I-80, with about 47% truck VMTs. Trucks have significantly different physical and driving characteristics than passenger cars, especially on grades, which has impacts on operational efficiency, safety and pavement deterioration. The presence of heavy vehicles reduces the capacity of freeway segments, with the reduction being more significant along specific grades. Trucks generally decrease speed by more than 7% on upgrades as compared to their operation on level terrains, according to the HCM 2010. The maximum speed that can be maintained by trucks on upgrades primarily depends on the length and steepness of the grade, as well as the truck's weight-to-power ratio. On the other hand, the operation of passenger vehicles is much less impacted by the grade. This leads to variations in speeds between trucks and passenger vehicles, with more complex interactions between the two types.

This study will look into impacts of truck traffic on selected freeway segments along I-80 in WY, as well as mitigation strategies to minimize negative impacts, through analyses of operational and safety implications that result from the interactions between trucks and passenger vehicles. The analysis will include the effectiveness of existing climbing lanes, and look into potential locations where the introduction of climbing lanes will be justified. The analysis will also look into other control strategies, such as different speed limits for trucks, truck lane restrictions along certain segments, and truck no-passing zones. Differential speed limits for trucks have been implemented by some US states, so this study will look into the state of practice and its effectiveness on operations and safety. Another potential issue with truck traffic on WY freeways is speed limit of 80 mph along certain segments. This raises a concern of the ability of

conventional truck tires to handle such high speeds. The study will look into this issue through a review of literature and practice, as well as through crash data analysis to identify the potential relationship between truck tire failure and crash characteristics.

The study will be divided into following tasks, where some of them can occur simultaneously.

Research Objectives:

The main research objectives of this study are as follows:

- Perform a review of literature and practice related to freeway truck traffic. The review will include operational and safety impacts of truck traffic and existing mitigation strategies. The effectiveness of climbing lanes, differential truck speed limits, truck lane restrictions, no-passing zones for trucks, updates in horizontal and/or vertical and cross section features of the road, updates in roadside, and installation or update of safety devices will be researched through literature and practice. Any potential relationship between high speeds, truck tire failure and safety will be looked into through literature review. The literature review will also provide some recommendations for the selection of data, analysis methodologies and results interpretation.
- Select freeway segments for case studies. The research team will collaborate with WYDOT to select freeway segments along I-80 that will be included in the analysis. The focus will be on segments with specific geometry, such as critical horizontal and vertical curves, specific upgrades/downgrades and selected freeway ramps. It is recommended to use existing data on freeway speeds, crash frequencies and crash characteristics that involved trucks to select these segments. It is recommended to use about ten locations with different characteristics.
- Collect data needed for analysis. The research team will identify the traffic data needed for the analysis, and the existing data sources. At the minimum, the data need to include geometrical characteristics of selected locations (horizontal and vertical alignments, cross section elements, roadside elements, ramp characteristics, auxiliary lane dimensions), operational characteristics (traffic volumes, traffic composition, lane utilizations, lane speeds) and safety data (crash locations, frequencies and types for the previous three to five years).
- Analyze existing data. The collected data will be used to perform operational and safety analysis for the selected segments. Within the operational analysis, measures of effectiveness such as segment capacity, distribution of vehicle speeds and headways, variations in speeds, densities, percentage of time spent following and the Level of Service (LOS) will be included. The analysis will be performed using a combination of methods, such as Highway Capacity Manual (HCM) methodology, shock wave analysis, simulation modeling and other methodologies recommended in the literature. Safety analysis will look into the distribution of crash rates and crash types, as well as the crash causation factors for different segments. Special attention will be paid to truck tire failures and potential link to high truck speeds.
- Identify potential control and mitigation strategies to improve operations and safety on freeways. With the analysis of data providing operational and safety measures of effectiveness, the research team will look into different control strategies that can be implemented at selected locations in order to improve operational and safety performance. Some of these strategies and improvements may include introducing

differential truck speed limits, adding climbing lanes, truck lane restrictions, introducing no-passing zones for trucks, changes in horizontal and/or vertical features of the road, changes in cross section, changes in roadside, and installation or update of safety devices (guardrails, delineators, chevrons, speed advisory signs, pavement markings and similar).

Research Methods:

The study will use the review of literature and practice, collection and analysis of the existing field data, such as geometrical characteristics of freeway segments, operational characteristics (traffic volumes, traffic composition, lane utilizations, lane speeds) and safety characteristics (crash locations, frequencies, types, causes) to determine the measures of operational and safety effectiveness of freeway truck traffic. Within the operational analysis, measures of effectiveness such as segment capacity, distribution of vehicle speeds and headways, variations in speeds, densities, percentage of time spent following and the Level of Service (LOS) will be included. The analysis will be performed using a combination of methods, such as Highway Capacity Manual (HCM) methodology, shock wave analysis, simulation modeling and other methodologies recommended in the literature. Safety analysis will look into the distribution of crash rates and crash types, as well as the crash causation factors for different segments. It will be based on the methodologies provided in the Highway Safety Manual, as well as others methodologies recommended in the literature and practice for truck traffic analysis. Based on the results of the analysis, potential mitigation strategies will be discussed and analyzed.

Expected Outcomes:

The first outcome of the study will be a synthesis of existing literature and practice related to freeway truck traffic, as well as the existing strategies used by agencies in order to improve operations and safety on freeways with high truck volume percentage. The second outcome will be complete sets of roadway and traffic data collected under the existing conditions. The data will be useful for engineers, educators and other interested stakeholders including, but not limited to, WY institutions, and can be used in potential future projects. The third outcome will be the assessment of current operational and safety conditions for freeway segments with high truck volume percentage and challenging geometric features. It will provide insights for potential problems, and the ways how to mitigate them. The study will describe current conditions, impacts, and mitigation recommendations.

This research would be beneficial for WYDOT, as it looks to improve operations and safety on freeways with high truck volume percentage. Furthermore, it will be useful to agencies across the US that face similar problems with freeway truck traffic. The data and analysis methodologies collected and developed throughout the study can be used in future research projects.

Relevance to Strategic Goals:

This study will have a major relevance to the safety strategic goal. A significant portion of crashes on WY freeways involve trucks, or are caused by trucks. Discovering major causes and implementing certain strategies for operational and safety improvements can help mitigate some of those problems and improve safety for all users. The study will also be relevant to economic competitiveness. Transporting goods safely and on time is of high importance to the trucking industry, so any strategies that can improve operations and safety for trucks will be very beneficial. Reduction of crash costs through safety improvements is another important element

related to this goal. Both improved operations and safety have impacts on the environmental sustainability strategic goal. Better operations of truck and car traffic reduce emissions and energy consumption, while reduction of crashes reduces impacts on environment by eliminating debris and spills, especially from trucks that transport certain hazardous materials. Truck traffic has significant impacts on road infrastructure, so this study will in some ways be related to the state of good repair strategic goal.

Educational Benefits:

Students will be involved in all aspects of this study, and it will provide a good material for transportation courses in operations, safety, planning and design. The students will perform main tasks in literature review, data collection and data analysis. The data analysis will include transportation operations and safety methodologies, software, as well as mathematical tools, giving the students an opportunity to expand their knowledge in these fields. If the analysis requires simulation modeling, the students will have the opportunity to learn and work with traffic simulation software, which is more and more being used by companies and agencies.

Work Plan:

The work plan is divided in four phases, with each phase consisting of one or more tasks. The phases and tasks are as follows:

Phase 1: Review of Literature and Practice

The research team will look into the existing research studies, guidelines and best practices from different agencies related to the analysis of truck traffic on freeways. The literature review will provide some recommendations for the selection of data, analysis methodologies, results interpretation, and potential improvement strategies.

Phase 2: Case-Study Selection and Data Collection

The research team will collaborate with WYDOT to select freeway segments along I-80 that will be included in the analysis. The focus will be on segments with specific geometry, such as critical horizontal and vertical curves, specific upgrades/downgrades and selected freeway ramps. After the case studies have been selected, the research team will identify the traffic data needed for the analysis, and the existing data sources. At the minimum, the data need to include geometrical characteristics of selected locations (horizontal and vertical alignments, cross section elements, roadside elements, ramp characteristics, auxiliary lane dimensions), operational characteristics (traffic volumes, traffic composition, lane utilizations, lane speeds) and safety data (crash locations, frequencies, types and causes for the previous three to five years).

Phase 3: Data Analysis and Results

The collected data will be used to perform operational and safety analysis for the selected segments. Within the operational analysis, measures of effectiveness such as segment capacity, distribution of vehicle speeds and headways, variations in speeds, densities, percentage of time spent following and the Level of Service (LOS) will be included. The analysis will be performed using a combination of methods, such as Highway Capacity Manual (HCM) methodology, shock wave analysis, simulation modeling and other methodologies recommended in the literature. Safety analysis will look into the distribution of crash rates and crash types, as well as the crash causation factors for different segments. It will be based on the methodologies provided in the

Highway Safety Manual, as well as others methodologies recommended in the literature and practice for truck traffic analysis

Phase 4: Identification of Control and Mitigation Strategies

With the analysis of data providing operational and safety measures of effectiveness, the research team will look into different control strategies that can be implemented at selected locations in order to improve operational and safety performance. Some of these strategies and improvements may include differential speed limits for trucks, adding climbing lanes, truck lane restrictions, introducing no-passing zones for trucks, changes in horizontal and/or vertical features of the road, changes in cross section, changes in roadside, and installation or update of safety devices (guardrails, delineators, chevrons, speed advisory signs, pavement markings and similar).

Project Cost:

This is a two-year study. The funding for the first year is as follows:

Total Project Costs: \$107,069

MPC Funds Requested: \$53,405

Matching Funds: \$ 53,664 Source of Matching Funds: UW

TRB Keywords:

Freeway Truck Traffic, Freeway Operations and Safety, Truck Speed Limit, Climbing Lanes