Research Summary

Uncovering the Root Causes to Truck Rollover Crashes on Ramps

Research Need

Crashes involving heavy trucks account for about 4% of all crashes but 8% of fatal crashes in the U.S. Of all truck crashes, approximately 11% occur on highway ramps, and between 44 to 52% of them result in rollovers. The sharp curves of ramps make them hotspots for truck rollovers, causing severe congestion. Understanding the root causes of ramp truck rollovers is crucial for developing effective strategies to improve highway safety and traffic operational reliability.

Goals/Objectives

This research aims to

(1) review literature and best practices on reducing highway ramp truck rollovers;

(2) analyze historical ramp heavy truck rollover data in Massachusetts;

(3) focus on utilizing traffic cameras and advanced video analytics tools to uncover the causes of heavy truck rollovers on highway ramps and derive surrogate safety performance measures; and

(4) establish correlations between truck rollovers and Intelligent Transportation Systems (ITS) devices, signage and markings, and roadway design practices.

Methodology

(1) conduct initial video data collection and preliminary data analysis to assess the quality of the video data.
(2) review literature and best practices for reducing truck rollover crashes on highway ramps and provide recommendations.
(3) conduct an in-depth analysis of ramp truck rollover crashes in Massachusetts to identify major contributing factors and high-risk ramps.
(4) collect additional video data at the identified high-risk ramps and develop artificial intelligence (AI) algorithms to analyze the collected video data and extract vehicle trajectories.
(5) identify high-risk events from trajectories to measure ramp safety performance and develop safety improvement strategies considering ramp geometry, traffic signage, pavement markings, etc.

Key Findings

Over 95% of ramp truck rollovers are single-vehicle crashes with speeding being the primary cause. Various dynamic warning signs and pavement markings are the two most widely used methods for reducing vehicle speeds and improving ramp horizontal curve safety. Artificial Intelligence (AI) has proven to be very useful in identifying key crash contributing factors not readily available in crash reports and helping to develop specific safety improvement strategies.

Use of Findings

The findings of this project suggest that the majority of ramp heavy truck rollovers occur at the beginning or end of a ramp. An effective strategy to reduce such rollovers is to prevent drivers from speeding. Among the reviewed strategies for reducing curve/ramp speeds, pavement markings and dynamic warning signs are the most commonly used. Dynamic warning signs that are activated by speed and vehicle type are preferred as they require less maintenance work.

The developed AI algorithms have the potential to detect high-risk events and analyze trajectories from other sensors, such as high-definition radar. They provide important insights into driver behavior, enabling the development of targeted and effective safety improvement strategies. These algorithms can also be utilized as a useful tool for conducting road safety audits.

A new pipeline has been developed and demonstrated to investigate traffic safety problems by combining network screening with detailed trajectory data collection and modeling. This approach empowers transportation agencies to proactively address traffic safety issues at similar facilities.

Project Information

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