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State of the non-operations based research of hard shoulder running

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Abstract

Hard Shoulder Running (HSR) is an operationally focused active traffic management strategy to optimize the utilization of the roadway, specifically the shoulder portion of the roadway geometry. Roadway networks needs to be more sustainable by utilizing its full capacity before using more materials to construct an expanded roadway. The understanding of the operational benefits has been the focus of much HSR research as it is an operational focused Active Traffic Management (ATM) strategy. Before HSR can be utilized, its effects on safety and the pavement structure on the shoulder need to be understood. While it has been found to improve the road operation, it must be safe and structurally sound. This paper provides a literature review of the HSR research that analyzed the safety effects and the pavement performance effects. HSR is a quality strategy that can reduce congestion, car emissions, and paved lane use requirements through improved traffic flow.

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Keywords: Hard Shoulder Running; Active Traffic Management; Sustainable Roadway Network; Safety Performance; Shoulder Pavement Performance

1. Introduction

Hard Shoulder Running (HSR) is the utilization of the shoulder of a roadway during high congestion periods and provides a temporary roadway capacity increase during the time period where there is need. This strategy is part of

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the Active Traffic Management (ATM) approach being recommended by the Federal Highway Administration (FHWA). HSR focuses on improving the operational efficiency of the roadway, hence the main research emphasis surrounding the topic is based upon operational benefits. The issue with this process is that there are other major factors to account for before fully understanding the implementation benefits of HSR. Two major factors to account for are the safety effects and the pavement effects. Each has major impacts on the utility of this strategy. Accounting for both aspects in addition to the operational benefits will provide a more sustainable roadway network.

1.1. Safety Effects Background

Safety is a significant aspect to account for in analyzing a new operation-based strategy. Besides operational benefits, safety benefits were the next most researched benefits as they are the most noticeable roadway aspect to be effected by HSR. While many drivers desire to get to their destination on-time, they also want to be able to arrive safely, as well. HSR removes the shoulder for major traffic periods of the day but this eliminates a continuous refuge area for vehicles that breakdown. This also removes the travel lane for emergency vehicles trying to reach a crash. The safety of a roadway can be estimated but the performance of the roadways is determined by the drivers utilizing the roadway. The benefits must analyze two parts of safety: if there is a higher inclination towards accidents and are their more accidents occurring on the roadways during HSR? The inclination towards accidents is to determine if the change in the geometry of lanes on the roadway negatively affect the safety. While there is a harmful effect for having a small or no shoulder, research needs to understand if the additional lane provides safety benefit to counterbalance the minimal shoulder effect. If this strategy negatively affects the concept of the roadway in the design process then the strategy may need an alteration to minimize the effects. The second aspect of safety that needs analysis is if the safety is negatively affecting the roadway once HSR is implemented. This research focus will improve upon the HSR strategy based upon possible flaws that may not have been accounted for within the initial design for this strategy.

1.2. Pavement Performance Effects Background

Pavement performance, while it affects operations and safety, is a distinct aspect of transportation that tends to have distance from the two other aspects. Pavement performance is a significant influence for the implementation of HSR. Any additional loading on a portion of a roadway will negatively affect the pavement performance. In the safety scenario, the shoulder is designed the same as the mainline lanes as the implementation of HSR could possibly improve the roadway performance. The use of HSR will distribute a major loading period on the roadway better than previously. For example, for a two lane roadway the split of the loading is roughly 50-50 and with HSR this roadway could be a loading split of roughly 33-33-33. The additional lane could possibly reduce the loading on a lane during high congestion by about 34% with that logic. Some operational based studies have found the split for a three lane HSR structure would be closer to a 40-40-20 split which would still provide a 20% loading reduction in the mainline lanes during high congestion [1]. This thought process is in the safest scenario as the shoulder pavement design is the same as the mainline lanes, also known as full depth shoulders. In fact, many states in the United States (US) are just beginning to switch to full depth shoulders, such as New Jersey, while others have varied shoulder design methods, such as Florida or Washington State [2, 3, 4]. The shoulder designs of these states are based upon a minimum cross section or a percentage of the truck traffic on the roadway [2, 3, 4]. These pavement cross section designs are minimal compared to the mainline lanes and the implementation of HSR could negatively affect the shoulder pavement performance greatly depending on the design. If the pavement degrades rapidly then the benefit of HSR can be offset as major rehabilitation will be required to repair the damage. For proper implementation of HSR, the effects of the shoulder designs on the pavement performance needs to be understood

1.3. Objectives

This paper is to review the current status of research of non-operational effects of HSR, specifically safety and pavement performance effect. The objective of this review paper is to identify the areas of strength along with the areas of improvement in current research that aims to account for the effects of HSR.