CENTER FOR TRANSPORTATION RESEARCH

PROJECT SUMMARY

Texas Department of Transportation

0-6713: Quantitative Relationship between Safety and Reduced Roadway Condition Maintenance

Background

In the past 5 years, over 12,000 fatalities, 48,700 incapacitating injuries, and 198,300 non-incapacitating injuries have occurred on the state-maintained highway network in Texas. The Texas Department of Transportation (TxDOT) is responsible for the maintenance of over 195,000 lane miles of highways, which substantially consists of pavements designed in the 1950s to 1970s that require continuously increasing maintenance due to aging infrastructure and increased traffic volumes. To make more effective use of the limited maintenance resources, TxDOT has initiated a project to study the potential impact of reduced funding on highway safety. The main objective of this project is to develop a methodological procedure to identify threshold levels of pavement skid resistance for highways in the context of traffic crashes, thereby assisting TxDOT Administration and engineers in making proper maintenance decisions. As a result, the efficiency and safety of the highway system could be preserved. The scope of this study covers all types of state-maintained highways in Texas.

What the Researchers Did

The researchers proposed a methodological framework for quantifying the relationship between crash risks and pavement skid resistance. First, a comprehensive review of the current practice of managing skid resistance to address safety concerns was carried out. Then, a comprehensive database was generated from four TxDOT-maintained databases. After that, a hierarchical grouping structure was developed to stratify the entire network into homogeneous groups by traffic level, speed limit, and the presence of horizontal curves. The impact of skid resistance on crash rate was established quantitatively with the development of Crash Rate Ratio (CRR)-Skid Number (SN) model to characterize curves for crash susceptibility under all weather conditions and under wet weather conditions. Critical skid resistance levels were then defined and identified for the whole network and each group. Finally, a benefit-cost analysis was performed to evaluate the determined threshold values for skid resistance. The proposed methodology enables decision-makers to make proper maintenance decisions during a budget shortfall so that the efficiency and safety of the highway system can be preserved.

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Compared to traditional regression models that are developed to describe the relationship between pavement skid resistance and crash risks, the CRR-SN model is specifically designed to support the management of skid resistance at the network level. The development of CRR-SN relationships provides both researchers and engineers an easy way to quantify and understand the quantitative relationship between skid resistance and crash risks. By choosing the break points of CRR according to the safety goals and objectives of the transportation agencies, the critical threshold values in terms of SN can be directly determined.

What They Found

Based on the analyses conducted, the researchers found that skid resistance has a negative impact on crash risk: the crash risk increases when the skid resistance decreases. Various general regression models were explored to correlate crash rate with potential variables affecting crash rate; however, because of the nature of the available data, no regression models were able to satisfactorily describe such relationships between the crash risk and the pavement skid resistance. The CRR concept developed under this study addresses the issues associated with the general regression models in achieving the goal of this project, as this model can be easily calibrated to provide a quantitative relationship between crash risks and skid resistance.

Based on the developed CRR-SN model, skid resistance thresholds can be determined easily according to the target crash risk level or expected crash reduction. The study yielded results that can be easily implemented by TxDOT in the maintenance decision-making process, thus promoting effective allocation of its resources.

What This Means

The research findings from this project allow TxDOT to manage its strategic goals in terms of safety by integrating safety into its pavement management plans. More specifically, using the recommended pavement skid resistance threshold values, TxDOT can identify pavement sections that require immediate treatments, more detailed project-level investigations, or vigilance. In addition, the CRR-SN relationships provide TxDOT an effective tool to control the level of crash risks it is willing to take by determining the corresponding level of pavement skid resistance it should maintain, which in turn allows TxDOT to estimate the funding it needs in order to keep safety at a predefined level. Furthermore, the research findings can serve as a solid basis for TxDOT to implement the performance measures and targets specified in MAP-21.

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