

0-6932: Developing Pavement Safety-Based Guidelines for Improving Horizontal Curve Safety

Background

Horizontal curves are an essential part of the rural highway system, yet they experience a disproportionate percentage of the state's crashes, particularly run-off-road and wet-weather crashes. It is desirable to implement safety countermeasures to reduce these crashes, but the presence of large numbers of curves on the system makes it essential to weigh the cost-effectiveness of proposed countermeasures.

Pavement-based countermeasures such as high-friction surface treatments have the potential to reduce wet-weather crash frequency by improving skid resistance. These treatments represent an intermediate-cost option because they are more expensive than installing signs and markings but less expensive than roadway realignment and straightening. To identify the best locations to install pavement treatments, it is necessary to weigh considerations of treatment cost, crash frequency, and exposure to wet-weather conditions.

What the Researchers Did

Researchers approached the project from two perspectives. First, researchers compiled field data describing the skid resistance of various pavement materials, including conventional treatments such as seal coat (or chip seal), hot-mix asphalt, and permeable friction course; and special treatments such as high-friction surface treatments. For materials that did not exist in the field in sufficient abundance to be tested,

researchers conducted laboratory testing to estimate skid resistance. Researchers produced estimates of treatment effectiveness in terms of initial and terminal skid numbers and rate of change of skid number. The latter values are essential to account for the reduction in skid resistance over time due to processes such as traffic polishing and weather degradation.

Second, researchers analyzed five years of crash data to determine the relationship between crash frequency, annual precipitation rate, skid resistance, and other geometric and exposure variables. They examined the distribution of wet-weather crashes across the state by total curve length, pavement skid resistance, and wet-weather exposure to develop guidelines for prioritizing curve sites for analysis and possible pavement treatment. The guidelines account for both precipitation and skid resistance, which are the two key variables for estimating wet-weather crash frequency on curves.

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Finally, researchers compiled the pavement and safety analysis results with pavement treatment cost data and formulated a detailed analysis framework. The spreadsheet tool framework allows the analyst to compute the life-cycle benefit of a proposed pavement treatment, accounting for potential crash reduction, treatment cost, and initial and terminal margin of safety. The margin-of-safety concept provides a detailed analysis method to account for friction supply, which depends on skid resistance, and friction demand, which depends on curve geometry and vehicle speed.

What They Found

On horizontal curves, wet-weather crash frequency is highly sensitive to both pavement skid resistance and annual precipitation rate. It is necessary to consider both variables to assess the potential effectiveness of a pavement friction treatment and to prioritize a list of candidate sites for treatment.

All pavement treatments can provide an initial boost in skid resistance, but the amount and longevity of improvement differ depending on the treatment and aggregate type. Additionally, different materials degrade at different rates

over time until they reach their terminal skid resistance value. Therefore, it is necessary to account for initial and terminal skid resistance, rate of change, and treatment cost to determine the life-cycle cost-effectiveness of a proposed pavement friction treatment.

What This Means

Current Texas Department of Transportation guidelines and policies identify three strategies for reducing wet-surface crash frequency:

- Wet-surface crash analysis.
- Pavement aggregate selection.
- Skid resistance testing.

These strategies are applied on a system-wide basis and implemented on the scale of roadway sections.

Researchers developed enhanced tools that assist practitioners in focusing on specific rural highway curve sites where the greatest potential exists to reduce wet-surface crash frequency. These sites are most likely to be located in parts of the state where rainfall rates are highest, and the sites are most likely to have pavements in need of resurfacing, such as flushed seal coats.

For More Information

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