Texas A&M Transportation Institute

Texas Department of Transportation

PROJECT SUMMARY REPORT

0-7067: Enhancing Freeway Safety Prediction Models

Background

Safety prediction models have been developed for urban freeway segments in Texas and elsewhere to apply to cross sections up to 10 lanes wide. These models are documented in resources such as the Texas Department of Transporation's (TxDOT's) *Roadway Safety Design Workbook* and the *Highway Safety Manual* (HSM), and are applied in several spreadsheet-based analysis tools. These tools are acknowledged in the *Project Development Process Manual* and have been used by various district personnel, particularly in the evaluation of project alternatives or analysis of design exceptions. However, additional research is needed to address knowledge gaps and develop updated local calibration factors for the models. Specifically, safety prediction models do not exist for 12-lane freeway segments or freeway segments with managed lanes (e.g., high-occupancy-vehicle or high-occupancy-toll lanes).

What the Researchers Did

The research team derived local calibration factors for models for urban freeway segments with 4–10 lanes and assessed the applicability of the 10-lane urban freeway model to freeway segments with 12 lanes. To accomplish this objective, the researchers assembled a database of about 2,400 urban freeway segments and over 80,000 crashes from the years 2015–2019. The researchers conducted several stages of calibration, including preliminary calculations using only crash data and traffic volumes, intermediate calculations that added geometric variables from the state roadway inventory into the analysis, and detailed calculations that added supplemental variables that the researchers collected from aerial and street-level photography sources. These variables included rumble strip presence, longitudinal barrier presence, and ramp locations, among others.

The researchers developed new safety prediction models for managed-lane segments on urban freeways. This effort required building a database of about 500 managed-lane segments varying by buffer type (i.e., barrier, pylons, or pavement stripes) and operation type (i.e., reversible or non-reversible). The researchers obtained traffic volumes for the managed lanes and obtained supplemental variables (e.g., cross-sectional widths and location and type of managed-lane access) from aerial photography sources. They also reviewed over 56,000 crash reports using narrative keyword analysis and manual review to assign crashes to the managed lanes or the adjacent general-purpose lanes.

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The researchers identified about 4,500 crashes that were directly associated with the managed lanes and used these crashes to calibrate safety prediction models specifically for the managed lanes. They also developed an analysis spreadsheet tool to help practitioners implement the new models to facilitate analysis of complex urban freeway configurations, such as cases where an urban freeway widening project requires challenging trade-offs between narrowing lanes or inside or outside shoulders.

What They Found

The researchers were able to derive local calibration factors to apply all HSM urban freeway models to Texas. Once the data from the detailed stage of data collection were incorporated into the analysis, all models could be adapted to Texas without having to calibrate new models. The researchers were also able to extend the HSM model for 10-lane urban freeway segments to segments with 12 lanes by using a different set of calibration factors. The researchers computed separate calibration factors for each lane count and for the different combinations of crash type (single vehicle versus multiple vehicle) and severity (fatal and injury versus property damage only).

The researchers developed new models to predict crash frequency in managed lanes on urban freeways. The safety performance functions for these models showed that for the same traffic volumes and geometric conditions, barrier-separated managed lanes will experience the fewest crashes, followed by stripe-separated managed lanes and then pylon-separated managed lanes. These models include crash modification factors to account for the safety effects of shoulder width and access point density (including ramps and weaving sections).

What This Means

TxDOT practitioners can use the local calibration factors to apply the HSM models to all urban freeway segments in Texas. The calibrated models allow practitioners to incorporate safety performance into the design and project development processes for urban freeway facilities. Practitioners can also use the newly developed models to predict safety performance for managed lanes on urban freeways in Texas. These resources will help with the complex trade-offs between safety, operations, community impacts, and cost that are often necessary when planning and designing urban freeway projects.

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