PROJECT SUMMARY REPORT

0-7083: Calibrating the *Highway Safety Manual* Predictive Methods for Texas Highways

Background

The *Highway Safety Manual* (HSM) contains safety performance functions (SPFs) that are used in project-level decision-making to estimate the average crash frequency by severity level for existing conditions, alternatives to existing conditions, or proposed new roadways. Because most existing HSM SPFs were developed for states other than Texas, SPF calibration is needed to apply for Texas highways. Calibration is conducted to account for differences in crash reporting procedures, thresholds, driver characteristics, animal population, and weather conditions, among others. Moreover, the HSM does not contain predictive models for frontage roads, yet Texas has a large network of frontage road segments that are part of the freeway system. In addition, ramp models in the HSM are not applicable to Texas due to differences in ramp configurations. Notably, ramps in Texas usually connect the freeway mainline to the adjacent frontage road rather than directly to the perpendicular road, as is typical in the states used for developing the SPFs in the HSM.

What the Researchers Did

Researchers assembled datasets for rural two-lane highways, rural multi-lane highways, rural freeways, and urban arterials. These data were assembled for both roadway segments and intersections. Researchers used the network provided by HERE Traffic Analytics and developed a statewide database of about 900,000 intersections. Researchers then obtained crash data, traffic volumes, and geometric variables from the state roadway inventory and collected supplemental variables from aerial and street-level photography sources. Next, researchers derived local calibration factors for the SPFs documented in the HSM Chapters 10, 11, 12, and 18. Researchers also used various goodness-of-fit measures to assess the quality of the estimated calibration factors.

New safety prediction models for frontage roads and ramp segments were subsequently developed. This effort required building a database of about 900 segments that included one-way and two-way frontage roads in both rural and urban areas. The ramp database includes about 650 entrance and exit ramp segments. In Texas, all crashes on frontage roads and ramps are assigned to the centerline of the main roadway, and the precise location of the crash is unknown (left or right frontage road or ramp). To overcome this issue, researchers developed a procedure to assign the crash to an appropriate ramp or frontage road segment. Doing so helped researchers locate about

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70 percent of the relevant crashes. For the remaining crash cases, the team primarily checked the crash diagram in the crash report and manually compared it with the roadways on aerial photographs.

Researchers also developed an analysis spreadsheet tool to help implement the new models and facilitate analysis of all rural and urban roadway segments and intersections. In particular, the tool assists in estimating the average crash frequency at a particular site and in evaluating different cross-sectional alternatives.

What They Found

Researchers derived reliable local calibration factors for most of the SPFs in the HSM. For facilities with poor calibration factors, researchers developed new SPFs using Texas data and developed regional calibration factors for all facility types, which are needed due to safety performance differences in different regions of the state. For example, different regions with similar roadway characteristics may experience different crash numbers due to differences in terrain, population, weather, and other unobserved characteristics that can impact the calibration procedure and consequently the calibration factor if used for the whole state. Thus, based on region-specific and statewide factors, the team developed an adjustment factor to be used in conjunction with the statewide factor to estimate the crashes accurately.

Researchers developed new SPFs for one-way and two-way frontage road segments and ramp segments. For frontage roads, the significant variables that influence crashes include left and right shoulder widths, access point density, presence of entrance and exit ramps, posted speed limit, and horizontal curve density. Analysis showed that two-way frontage roads experience fewer crashes than one-way frontage roads though they are more severe. For ramps, the influential variables are left and right shoulder widths, presence of horizontal curves, and longitudinal barrier presence and offset. Exit ramps experience more crashes than entrance ramps. The SPFs account for single- and multiple-vehicle crashes separately.

What This Means

Texas Department of Transportation (TxDOT) practitioners can use the safety prediction method updated in this research to incorporate safety performance into the network screening, design, and project development processes for roadway segments and intersections in both rural and urban areas. Practitioners can also use the newly developed models to predict safety performance for frontage roads and ramp segments. These resources will form a powerful tool for selecting Highway Safety Improvement Program projects and support and defend safety decisions that the Design Division and districts make. Other state agencies, such as metropolitan planning organizations, may find the results useful when evaluating and prioritizing project alternatives. TxDOT may also want to update its *Project Development Process Manual* to acknowledge the research report and spreadsheet tool in the section where the HSM is currently mentioned or in sections addressing alternative analyses.

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