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Using reliability models for crash frequency analysis on the Saskatchewan highway network

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Abstract

The present study demonstrated the potential applications of reliability models for crash analysis of a large highway network. Specifically, three major outcomes of reliability models were investigated: temporal distributions of crashes, reliability score, and expected number of crashes. These parameters were derived using 20 years of crash data (2001-2020) recorded on the Saskatchewan highway network, although time sensitivity analysis is addressed for 5, 10, 15, and 20 years of crash data. A series of reliability models were developed for crashes by crash severity, vehicle involvement, and highway type at both the segment and highway levels. First, the temporal distributions of crashes on each segment were fit to a statistical distribution. Second, the reliability scores were used to rank the high crash-risk segments and visualize the weekly reliability of each segment on the map of the Saskatchewan highway network using ArcGIS software. Third, the mean expected crash frequency was used to develop network-wide safety performance functions for total and fatal crashes in urban and rural highway segments using Poisson-Tweedie (PTw) regression models. The developed PTw models showed that the presence of trucks in the traffic composition has a significant effect on crash frequency, especially for urban highway segments. Moreover, the use of reliability-based safety performance functions (SPFs) will allow safety analysts to rely on probabilistic rather than deterministic network screening approaches. The findings from this study push highway authorities to introduce reliability models in the decision-making of safety investment plans. Also, the framework of reliability modeling is transferable and can be developed for the highway networks of other provinces or different weather conditions.

Keywords: crash frequency analysis, reliability theory, temporal aspects, prediction models

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