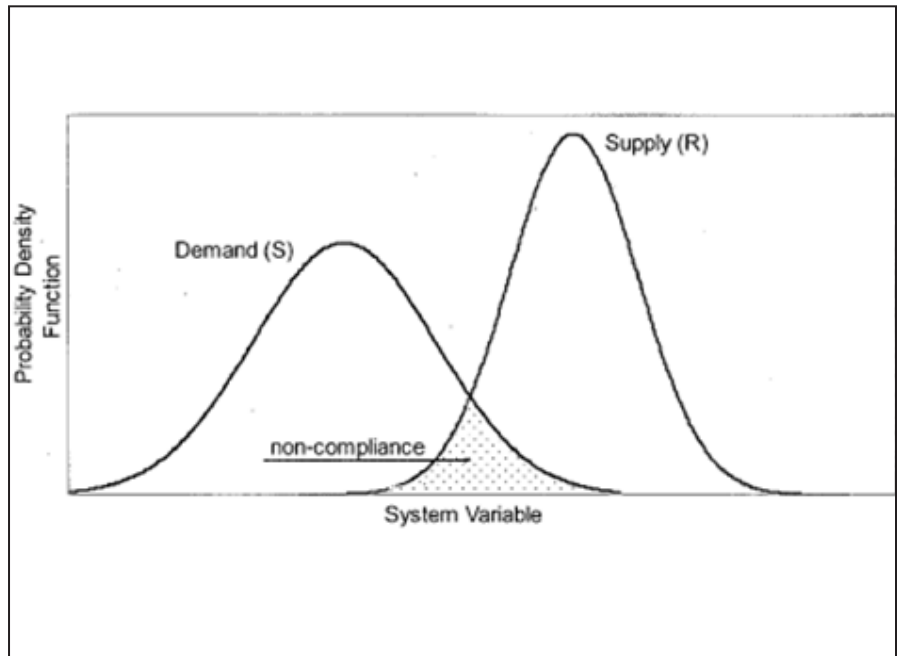


MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 19-408 (project 406) | October 2019

Risk-and-Reliability-Based Approaches to Analyzing Road Geometric Design Criteria



the ISSUE

Performance measures are being used to increase accountability for how highway funds are being spent and allocated. At the same time, there is often a large variability in the factors influencing highway design criteria (e.g., road conditions, driver/vehicle performance), and the likelihoods that design alternatives will meet performance goals are not explicitly or quantitatively evaluated, but rather addressed by using “conservative” values based on design criteria derived from tables, charts, and equations. This can lead to performance outcomes (reductions in crashes, congestion, or fatalities) that are different than intended.

the RESEARCH

This research critically assesses alternative approaches for incorporating risk-and-reliability analysis when establishing road geometric design criteria and design decisions. Researchers did an in-depth investigation of the applicability of reliability analysis, which was used to estimate the probability distribution of operational performance that might result from a basic number of lane decisions made to achieve a design level of service on a freeway. Geometric effects of freeway ramp spacing and auxiliary lane presence on crash frequency and crash severity were also analyzed. Negative binomial and multinomial logit regression models are used to estimate the effects of ramp spacing and auxiliary lane presence on expected crash frequencies and crash severities, respectively.



A University Transportation Center sponsored by the U.S. Department of Transportation serving the Mountain-Plains Region. Consortium members:

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University of Utah

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Project Title

Risk-and-Reliability-Based
Approaches to Analyzing
Road Geometric Design
Criteria

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the FINDINGS

Applications in this research included three main areas. In the first area, the probability of a design not performing as intended (i.e., non-compliance) was assessed for selected design criteria, including their uncertainty. This provides a designer with new information on the reliability of a design and the associated risk in the form of non-compliance probability. In the second area, uncertainty was considered for vehicle density and level of service, so that a designer would have estimates of the probability that the design LOS will or will not be met in the design year. Lastly, in the third area, the safety effects of ramp spacing and auxiliary lane presence on crash frequencies and severities were modeled. Results showed that expected multi-vehicle crash frequency increased but crash severity decreased as ramp spacing decreased; whereas, adding an auxiliary lane had opposite effects with decreased crash frequency but increased overall crash severity.

the IMPACT

The proposed performance-based processes for establishing design criteria would allow designers to consider and balance the accommodation of driver and vehicle operating characteristics, safety, design, and construction costs in any given context. More specifically, the applications described for assessing probability of compliance of a design, the expected level of service given a number of lanes on a freeway segment, and the effect of ramp spacing and the presence of an auxiliary lane will provide clear paths for utilization of these methods and improve reliability of performance estimates at design stages. Such a performance-based design approach would be a significant contribution to achieving performance objectives and making well-informed design decisions.

For more information on this project, download the entire report at <https://www.ugpti.org/resources/reports/details.php?id=1024>

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.



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