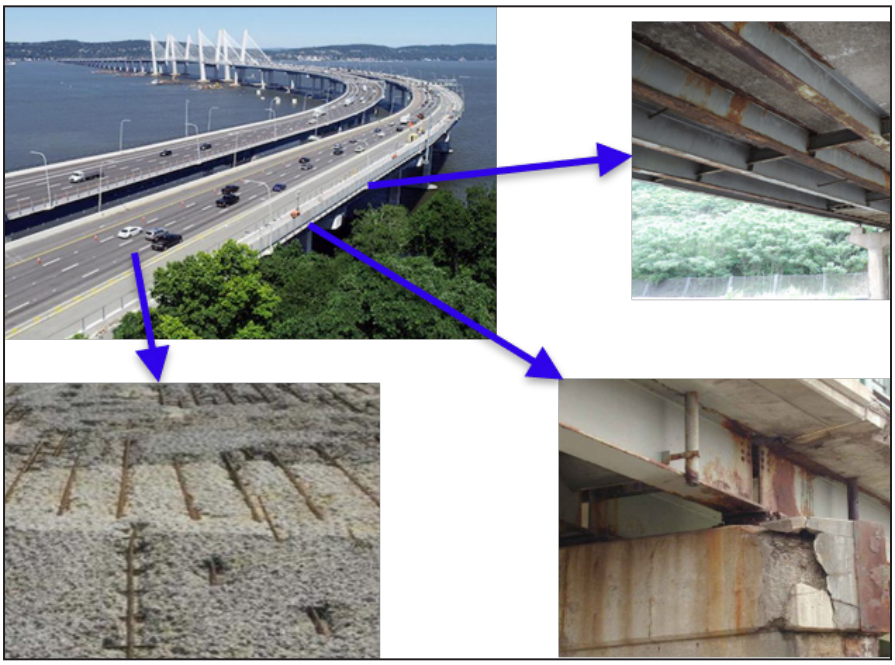
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 24-560 (project 536) | September 2024

Development of Age and State Dependent Stochastic Model for Improved Bridge Deterioration Prediction



the ISSUE

Bridges deteriorate at different rates due to factors like age, environment, and traffic. Traditional models fail to account for these variations, leading to inaccurate bridge deterioration predictions and less cost-effective inspection and maintenance planning.

the RESEARCH

This research developed a non-homogeneous Markov model for predicting bridge deterioration, which accounts for time-variant factors such as age, environmental conditions, and traffic load. Traditional models assume constant deterioration rates, leading to inaccurate predictions. To improve accuracy, the new model incorporates time-variant transition probabilities that reflect real-world changes in bridge conditions over time. The model was calibrated using a large dataset of bridge inspection data from the National Bridge Inventory and environmental variables from the Long-Term Bridge Performance Program. By using a Bayesian approach, the model adapts to newly available data, allowing for continuous improvement in prediction accuracy. The model's ability to account for varying factors provides transportation agencies with better tools for scheduling inspections, planning repairs, and managing long-term maintenance. This results in safer, more reliable bridges and more cost-effective use of maintenance resources.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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

Colorado State University
North Dakota State University
South Dakota State University
University of Colorado Denver
University of Denver
University of Utah
Utah State University
University of Wyoming

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Project Title

Development of Age and State Dependent Stochastic Model for Improved Bridge Deterioration

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the FINDINGS

The developed non-homogeneous Markov model significantly improves the accuracy of bridge deterioration predictions compared with traditional methods. The model accounts for varying factors such as age, traffic, and environmental conditions, which traditional models overlook. When tested on bridges in Colorado, the model provided more accurate deterioration predictions, enabling better-informed decisions for inspection and maintenance planning. This improvement in accuracy leads to more efficient use of resources and enhances bridge safety by allowing for timely interventions. The model's adaptability allows it to incorporate new data, ensuring continued effectiveness in predicting deterioration over time.

the IMPACT

This research will improve the safety and longevity of bridges by providing transportation agencies with a more accurate tool for predicting deterioration. Because the developed deterioration models account for differences in the condition, environment, and deterioration rate of different bridges, these models can provide more accurate deterioration and condition prediction for individual bridges. Therefore, these deterioration models can be used to provide inspection and maintenance plans tailored for each bridge to not only ensure bridge preservation but also reduce unnecessary inspections and lower costs.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1204

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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