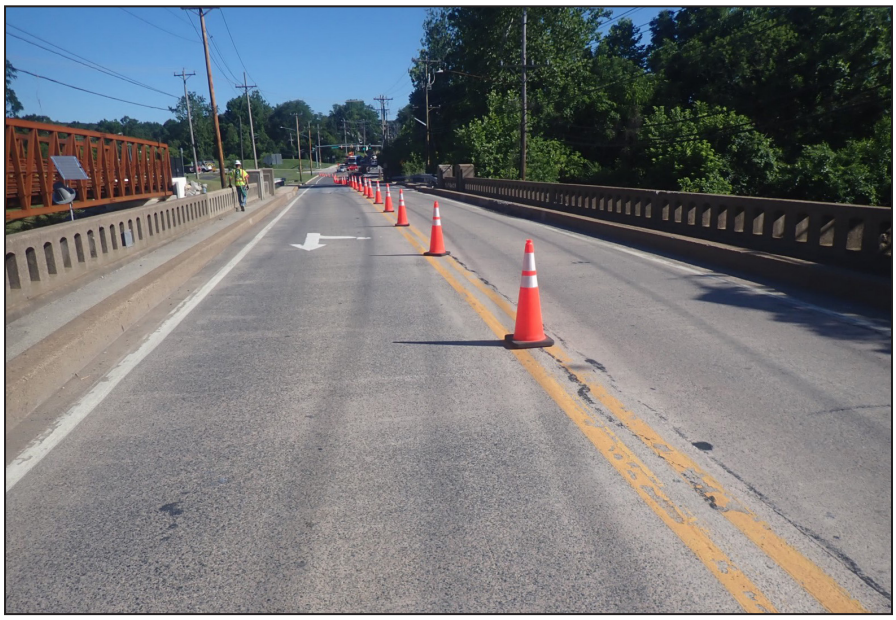
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 25-579 (project 618) | October 2025

Addressing the Feasibility of Employing NDE Data for Bridge Condition Assessment Using Gaussian Process Regression



the ISSUE

Bridge decks deteriorate due to traffic and weather, but current inspection ratings are subjective and often miss hidden damage. Non-destructive testing provides better data but is expensive and limited. Agencies need tools to stretch the value of available data and prioritize where to focus costly inspections.

the RESEARCH

This project tested whether limited non-destructive evaluation (NDE) data can be used to predict bridge deck deterioration more effectively. NDE tests, such as Impact Echo, provide objective measurements of deck damage, but they are costly and not collected regularly. Using bridge data from the Federal Highway Administration's Long-Term Bridge Performance program, the research team applied a statistical learning model to estimate deck delamination. The model was trained on 20 sets of NDE records and included variables such as deck thickness, traffic levels, freeze-thaw cycles, and design details.

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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
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University of Utah
Utah State University
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Project Title

Investigating the Applicability of Multi-Fidelity Modeling to Evaluation of Transportation Infrastructure

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the FINDINGS

The research showed that it is possible to predict bridge deck delamination using limited NDE records with good accuracy. The model achieved error levels around 10% to 11%, which is acceptable for early-stage planning. Freeze-thaw cycles and deck thickness were found to be the most important factors influencing deck deterioration. A key outcome is that the model provides a built-in uncertainty estimate. This means that bridges with high uncertainty can be flagged for priority testing, ensuring that limited inspection resources are directed where they will reduce uncertainty the most. In this way, the model can both forecast deterioration for untested bridges and improve the efficiency of future inspection programs.

the IMPACT

Despite the small dataset, the model achieved reliable accuracy in predicting delamination for bridges similar to those in the training data. Importantly, the model also produced an uncertainty measure with each prediction, which can guide agencies on where additional testing would be most valuable. This approach not only leverages existing data but also lays the foundation for inspection planning tools that can direct limited NDE resources to bridges where they will have the greatest impact.

This research introduces a cost-effective way to maximize the value of limited non-destructive evaluation bridge inspection data. These tests are costly and not conducted regularly. By predicting delamination and highlighting where uncertainty is greatest, transportation agencies can prioritize inspections, better target maintenance resources, and avoid unnecessary testing. The approach helps extend the useful life of bridge decks by ensuring early damage detection and timely repairs. If applied widely, it could improve safety, reduce maintenance costs, and provide significant savings on rehabilitation and replacement. The method also creates a foundation for smarter, data-driven decision-making in bridge asset management.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1267

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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