

# MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 18-346 (project 449) | July 2018

## Methodology for Uncertainty-Based Inspection Planning of Concrete Bridge Decks Using Mechanistic Models of Crack Formation and Propagation



### the **ISSUE**

Bridge inspection is an important part of bridge management. Currently most bridges are visually inspected every two years, as required by federal law. This approach to inspection is not very efficient and a different means of planning inspections might give better information about bridge condition while also reducing costs.

### the **RESEARCH**

This research investigates a new approach for planning inspections. The premise of the approach is that inspections are conducted to gather information about bridge condition for decision making about bridge maintenance. Therefore, inspections only need to be conducted when the bridge condition is not well understood (i.e. the level of uncertainty in bridge condition is high). For this project, researchers considered the particular case of reinforced concrete bridge decks subject to cracking and delamination. An uncertainty-based approach to inspection planning is investigated using an analytical model to predict the condition of the bridge deck in the future. Probabilistic inputs are used in the model and when the predicted condition of the bridge deck has a high degree of uncertainty, it is time to plan an inspection. The research also considers the application of nondestructive evaluation methods in a preliminary way. Reasonable values for inspection uncertainty are assumed for different NDE techniques, and the reduction in bridge condition uncertainty resulting from an inspection is predicted using Bayes Theorem. Only those inspection techniques that are capable of effectively reducing the uncertainty in bridge condition should be considered as suitable methods of inspection.



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



### Lead Investigator(s)

Rebecca Atadero  
atadero@colostate.edu

Mehmet Ozbek  
mehmet.ozbek@colostate.edu

Colorado State University

### Project Title

MEMS Sensors for  
Transportation Structures

### Research Assistant(s)

Patrick Sanders, GRA, MS

### Sponsors | Partners

USDOT, Research and  
Innovative Technology  
Administration

### the FINDINGS

The research report demonstrates that an uncertainty-based approach to inspection planning is viable and has the potential to better allocate inspection resources. However, the research also brought to light many factors that limit our current ability to apply such an inspection planning technique. These factors include limitations in current models for predicting bridge deck deterioration and in understanding the accuracy of various NDE methods for bridges.

### the IMPACT

The anticipated impact of this research is a new means of planning inspections that will save money while also providing a better understanding of bridge condition. A follow-up study investigating life-cycle costs associated with inspection is expected to provide a quantitative measure of the potential benefits.

For more information on this project, download the entire report at <http://www.ugpti.org/resources/reports/details.php?id=916>

For more information or additional copies, visit the Web site at [www.mountain-plains.org](http://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.



This publication was produced by the Mountain-Plains Consortium at North Dakota State University. The contents of this brief reflect the views of the authors, who are responsible for facts and the accuracy of the information presented herein. This document is disseminated under the program management of the USDOT, Office of Research and Innovative Technology Administration in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.



NDSU does not discriminate in its programs and activities on the basis of age, color, gender expression/identity, genetic information, marital status, national origin, participation in lawful off-campus activity, physical or mental disability, pregnancy, public assistance status, race, religion, sex, sexual orientation, spousal relationship to current employee, or veteran status, as applicable. Direct inquiries to Vice Provost, Title IX/ADA Coordinator, Old Main 201, 701-231-7708, [ndsueoaa@ndsu.edu](mailto:ndsueoaa@ndsu.edu).