MOUNTAIN-PLAINS CONSORTIUM

PROJECT BRIEF | April 2014

A Novel Methodology for Quantifying the Performance of Constructed Bridges in Cold Regions

the ISSUE

The Federal Highway Administration reports that 527,991 bridges in the nation are in operation without any restriction, while 3,578 bridges have been closed to all traffic due to their deficient conditions. Adequate evaluation and subsequent maintenance/rehabilitation are, therefore, important technical activities to ensure the reliable performance of bridge structures.

the RESEARCH

This report presents a two-part research program examining the performance of constructed bridges in a cold region, represented by those in the State of North Dakota, and the behavior of concrete members strengthened with carbon fiber reinforced polymer (CFRP) composite sheets. For the first phase of the research, 1,328 decks are sampled from a 15-year inspection period. These data are statistically characterized and probabilistically analyzed. The second part of the research concerns predictive investigations into the axial behavior of concrete exposed to aggressive service environments. Two types of concrete cylinders are studied: unconfined and confined with CFRP sheets. The aggressive environment and service traffic load are represented by freeze-wet-dry cycles with various levels of instantaneous compression load varying from 0% to 60% of the capacities of the unconfined and confined control concrete. Research approaches include three-dimensional deterministic finite element and probabilistic models, associated with a previously conducted experimental program.

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

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North Dakota State University
South Dakota State University
University of Colorado Denver
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the FINDINGS

The importance of timely technical action is discussed to enhance the condition rating of bridge decks in cold regions. The stochastic response of existing decks is effectively represented by Gaussian probability distributions, regardless of inspection years. The performance of the decks tends to converge to a certain state with time. The state-transition of the in-situ decks is identified through the global health index proposed. The effect of live load is found to be significant on the performance of the unconfined and confined concrete, including the variation of compliance and volumetric characteristics. The efficacy of CFRP-confinement increases when the intensity of live load increases. Reliability of the confined concrete is influenced by the environmental and physical conditioning.

the IMPACT

The research proposes a method to quantify the performance of constructed bridge decks in cold regions and their time-dependent behavior when subjected to an aggressive service environment. A CFRP-strengthening method is suggested to enhance the sustainability of constructed bridge members in cold regions. For practical implementation of the study, refined design recommendations such as strength reduction factors are proposed to address the detrimental contribution of environmental and physical attributes.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=767

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7938 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.