MOUNTAIN-PLAINS CONSORTIUM

PROJECT BRIEF | July 2015

Damage Assessment, Characterization, and Modeling for Enhanced Design of Concrete Bridge Decks in Cold Regions

(photo credit: WSDOT, Flickr.com)

the ISSUE

Freeze-thaw and fatigue-type loading processes degrade concrete materials and reduce the load carrying capacity of concrete decks. Damage to concrete decks is caused by the formation of cracks and micro-cracks during fatigue and freeze-thaw cycles. The extent of damage must be understood for a reliable design of concrete structures.

the RESEARCH

Advanced theories of damage mechanics are used to quantify damage (cracks) to concrete under fatigue and freeze-thaw cycles. Cracks that form during such processes alter mechanical properties of the material and render concrete more pliant. To quantify changes for an engineering design, a bounding surface approach along with anisotropic damage mechanic theory is used. A number of softening functions are proposed and introduced to capture the salient observed nonlinear behavior of concrete. The proposed models are subsequently compared with existing experimental data available in the literature. The comparisons show a satisfactory correlation.

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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
University of Colorado Denver
University of Denver
University of Utah
Utah State University
University of Wyoming

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Project Title

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the **FINDINGS**

New damage mechanics models for concrete inelasticity under fatigue loading and freeze-thaw cycles are developed. The research shows the versatility of using the bounding surface approach for obtaining the fatigue life and damage due to freeze-thaw cycles.

The research also shows that while the strength of concrete decreases with increase in loading cycles, the limit strain increases at the same time. These features must be incorporated in an engineering analysis for a more reliable design.

the **IMPACT**

The model allows advanced engineering analysis to be carried out by design engineers for safety and reliable concrete structures, such as bridge decks.

For more information on this project, download the entire report at http://www.ugpti.org/resources/reports/details.php?id=815

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.