

MOUNTAIN-PLAINS CONSORTIUM

PROJECT BRIEF | MPC 15-303 | December 2015

Fire Performance of Bridge Members Retrofitted with Near-surface-mounted Carbon Fiber Reinforced Polymer Composites

the ISSUE

Carbon fiber reinforced polymer (CFRP) composites are a promising material for upgrading or repairing existing bridge members. Like other structural components, CFRP-retrofitted bridge members are exposed to potential fire hazards. Repaired members must, therefore, demonstrate acceptable fire resistance to ensure adequate structural integrity until travelling vehicles are evacuated.



the RESEARCH

This research presents a two-phase experimental program studying 1) the interfacial response of NSM CFRP strips embedded along a concrete substrate at elevated temperatures and 2) the behavior of NSM CFRP strips for strengthening concrete members subjected to thermomechanical distress (thermal and mechanical loads are applied simultaneously).



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

Yail Jimmy Kim
University of Colorado
Denver
jimmy.kim@ucdenver.edu

Project Title

Fire Performance
of Bridge Members
Retrofitted with Near-
surface-mounted Carbon
Fiber Reinforced Polymer
Composites

Research Assistants

A. Namrou
T. Siriwardanage

Sponsors | Partners

University of Colorado
Denver

North Dakota State
University

USDOT, Research and
Innovative Technology
Administration

the FINDINGS

Although the residual strength of concrete and CFRP is not influenced by thermal exposure, effects were seen in the adhesives used. The performance of the CFRP-concrete interface bonded with an ordinary epoxy is better than the performance of a high-temperature adhesive without thermal distress, while the latter becomes superior to the former with an increase in temperature. The interaction between the adhesive and concrete controls the interfacial capacity and corresponding failure mode. The thermal relaxation of a polymeric bonding agent influences the transfer of interfacial stresses, including the stress-decrease response time of the interface with temperature. Transient heat flow is apparent across the interface until the strengthening system fails due to the thermomechanical load. The failure plane of the interface is governed by the progression of heat energy in conjunction with the phase transition of the adhesive. The slip of the interface articulates a thermal hysteresis mechanism when loaded cyclically.

the IMPACT

The research program has examined the behavior of NSM CFRP-concrete interface subjected to elevated temperatures. Experimental findings are useful for understanding the thermal response of constructed bridges strengthened with NSM CFRP composites, while analytical results assist practicing engineers who are interested in applying such strengthening technologies on-site.

For more information on this project, download the entire report at <http://www.ugpti.org/resources/reports/details.php?id=840>

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.



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.



North Dakota State University does not discriminate on the basis of age, color, disability, gender expression/identity, genetic information, marital status, national origin, physical and mental disability, pregnancy, public assistance status, race, religion, sex, sexual orientation, or status as a U.S. veteran. Direct inquiries to: Vice Provost for Faculty and Equity, Old Main 201, 701-231-7708; Title IX/ADA Coordinator, Old Main 102, 701-231-6409.