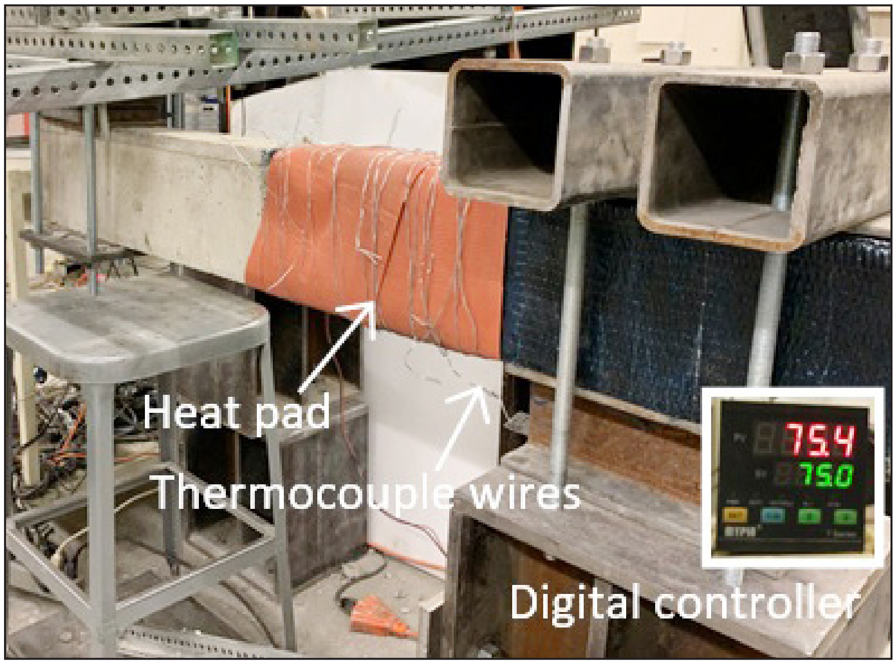
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 24-545 (project 613) | August 2024

Behavior of Composite-Strengthened Concrete Bridge Members under Multi-Hazard Loadings



the ISSUE

Design specifications for bridges and other structures traditionally treat structural loads loading separately without considering other hazards such as fire, scour, or wind. Multi-hazard design is an emerging concept that can address complex interactions and cumulative demands concerning the operational safety of structures. Seismic deficiency is a challenge facing U.S. transportation infrastructure. Composite materials such as ultra-high performance concrete (UHPC) and carbon fiber reinforced polymer (CFRP) are receiving special attention for retrofitting seismically deficient concrete members. However, these materials have not been tested under multiple hazards.

the RESEARCH

The research focused on the thermomechanical behavior of reinforced concrete beams strengthened with CFRP sheets and UHPC jackets. The beams were cyclically tested in a cantilever condition as per the FEMA 461 protocol at elevated temperatures varying from 25°C (77°F) to 175°C (347°F). After performing ancillary experiments, the hysteretic responses of the retrofitted beams were investigated with a focus on load-deflection relationships, flexural rigidity, energy dissipation, and inelastic failure states.

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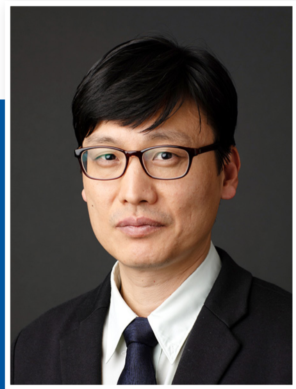

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Project Title

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the FINDINGS

Elevated temperatures are concerned with the pinching, plasticity, characteristic rigidity, stress redistributions, and energy-release patterns of test beams. Due to composite-based retrofit, the configuration of plastic hinges alters, and the localized sectional deformations form a narrow damage zone. The adverse effects of thermomechanical distress on rotational stiffness are pronounced during the early loading stage of the beams.

the IMPACT

The report clarifies the implications of multi-hazard loading for the behavior of reinforced concrete members retrofitted with advanced materials. Given that there is insufficient information on the subject matter, findings will advance the state of the art and impact the bridge engineering community.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1190

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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