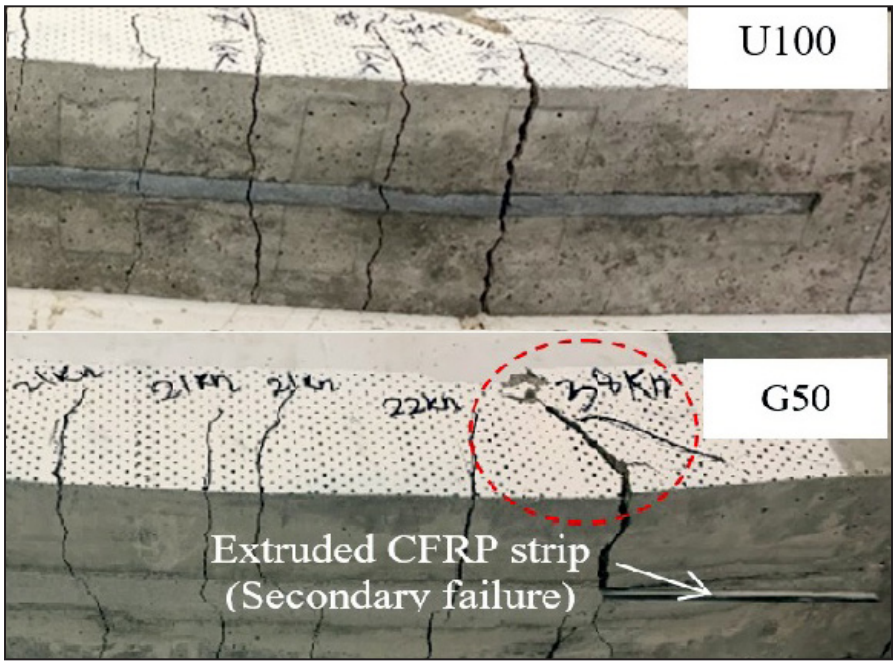
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 22-490 (project 648) | December 2022

Repairing Concrete Structures Using Near-Surface Mounted Composites with Inorganic Resins under Simulated Multi-hazard Damage



the ISSUE

As concrete structures age, including those in transportation infrastructure, rehabilitation strategies have been employed to upgrade the capacity and serviceability of load-carrying concrete elements. Near-surface-mounted (NSM) carbon fiber reinforced polymer (CFRP) is a viable option for affordably extending the lifespan of existing concrete members. In spite of known deficiencies, NSM CFRP technologies heavily rely on the use of organic epoxy resins. Drawbacks include degraded functionality under thermal distress, exothermic reactions, noxious fumes, and incompatibility with wet exteriors. Those involved in the rehabilitation of existing concrete structural members acknowledge the familiarity, efficacy, and customary adoption of such bonding agents, but practitioners are eager for a substitute that can overcome the limitations of epoxy adhesives under specific circumstances.

the RESEARCH

This research deals with an experimental program examining the pertinence of emerging inorganic resins to NSM CFRP and evaluates the behavior against that of mortar. Since inorganic resins generally need a long curing period relative to organic resins, progressive bond development is of interest.

Three types of emerging resins were taken into consideration: polyester silica, UHPC, and geopolymer. A wide variety of corrosion intensity was numerically simulated up to 100 years, and representative damage levels were chosen for laboratory testing. A total of 12 strengthened beams were loaded under four-point bending, and their load-carrying capacity, displacement, and failure modes were investigated. Additionally, the resins' workability was measured to understand the rheological suitability as a bonding agent for NSM application.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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

Repairing Concrete Structures Using Near-Surface Mounted Composites with Inorganic Resins under Simulated Multihazard Damage

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the FINDINGS

The post-peak response and energy dissipation of a composite concrete interface are controlled by resin types and curing periods. Analytical modeling quantifies the level of hazard and clarifies the functional equivalence of the interface with inorganic resins against conventional organic epoxy resins. The interfacial characteristics of the resins dominate the mechanical interaction between damaged internal reinforcing steel and CFRP, thereby altering the tendency of capacity drops, post-yield plateaus, and crack distributions. The provisions of existing design guidelines are evaluated, and a modification factor is suggested to promote the cementitious resins for NSM CFRP.

the IMPACT

When composite repair is carried out for concrete members, no specific guidelines are currently available. This research addresses this lack of information by suggesting design recommendations that will enhance use of NSM CFRP technologies for affordably rehabilitating concrete structures to extend their safe useful life.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1111

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.