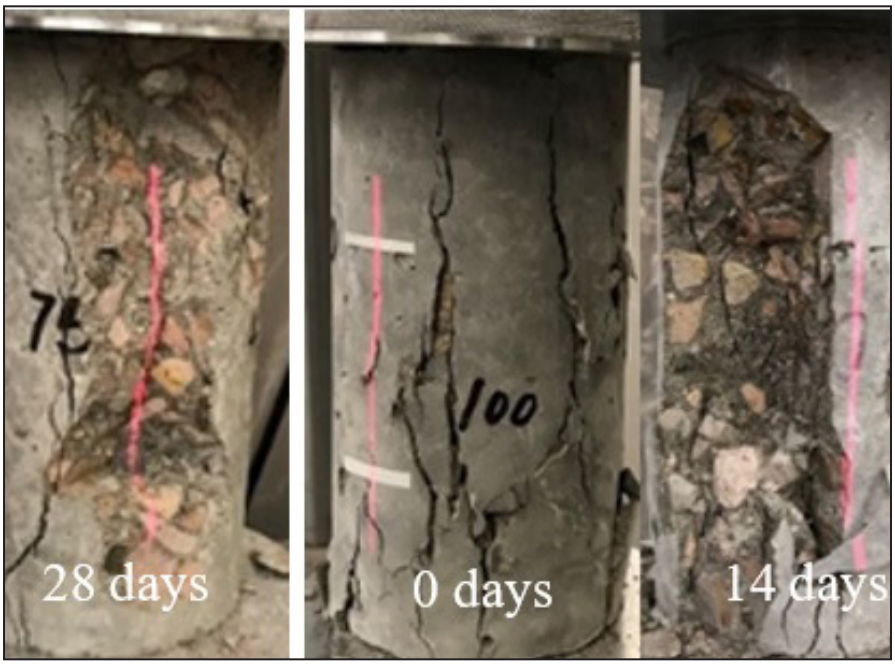
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 22-455 (project 583) | March 2022

Composite Repair for Concrete Bridges Subjected to Alkali-Silica Reaction



the ISSUE

Portland cement and aggregates are indispensable for producing concrete. An alkali-aggregate reaction between these two products over time frequently results in expansion and cracking of concrete. The reaction usually includes one of two forms: an alkali-silica reaction (ASR) or an alkali-carbonate reaction (ACR). Techniques are needed to repair bridges damaged by these reactions and to prolong their service lives.

the RESEARCH

This study discusses a test program aiming to explain the migration of ASR in concrete, the relationship between the progression of ASR and the response of CFRP-confined concrete, and failure specifics. Performance-based efficiency factors are proposed to translate research into practice.

The performance of carbon fiber reinforced polymer-confined concrete that has been exposed to an aggressive service environment (prior to strengthening) is intimately reliant upon the quality of the core. When concrete is impaired by ASR, the structure of the constituents becomes unstable, followed by a volumetric expansion and micro-cracking in the cement paste. Accordingly, the knowledge of CFRP-confinement established with ordinary concrete may not be sufficient for ASR-affected concrete. Moreover, published design guidelines do not render any information (fib 2001; ACI 2017; CSA 2017). The present research intends to understand the effects of ASR on the behavior of concrete confined with CFRP and suggests a methodology for practitioners to implement.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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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Utah State University
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Project Title

Composite Repair for Concrete Bridges Subjected to Alkali-Silica Reaction

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the FINDINGS

This research examines the behavior of concrete cylinders subjected to ASR with and without CFRP-confinement. To represent the variable amounts of ASR, reactive aggregates (rhyolite) substituted ordinary aggregates (granite) at a replacement ratio ranging from 0% to 100%, and the cylinders were conditioned as guided by ASTM C1260 (ASTM 2014a) in a corrosive sodium hydroxide solution. The time-dependent properties of the concrete and the solution were measured, and the progression of ASR through the concrete was optically assessed using a digital microscope.

the IMPACT

The structural responses of the plain and confined concrete specimens were examined with an emphasis on load-carrying capacity, toughness, and failure characteristics. An analytical model was developed to complement the experimental findings and to propose design recommendations.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1068

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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