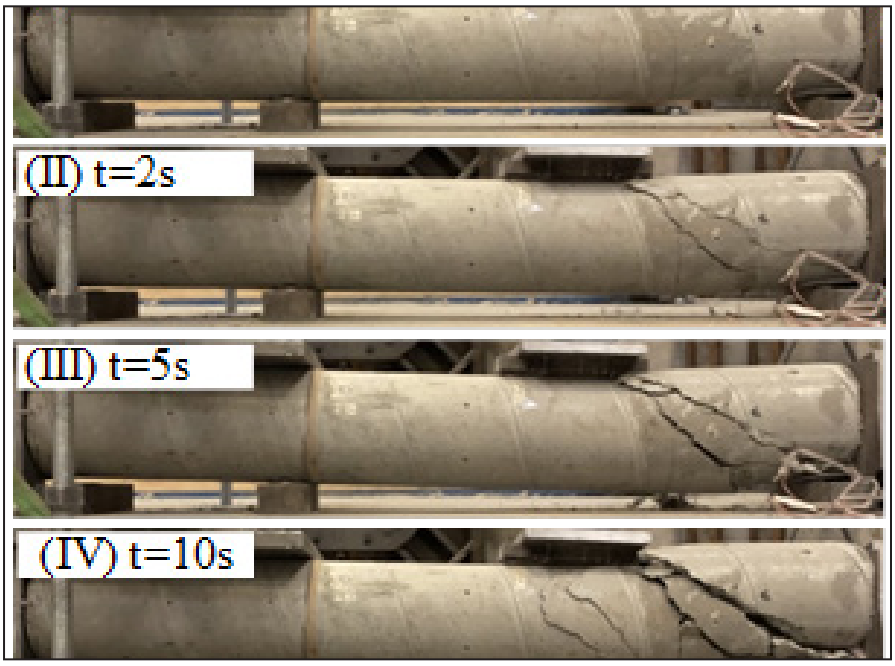
# MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 24-542 (project 696) | August 2024

## Numerical Evaluation of Precast Columns with Grouted Splice Sleeve Connectors under Sequential Impact and Seismic Loads




## the **ISSUE**

With the development of accelerated bridge construction (ABC) methods, the seismic performance of typical ABC column-footing connections has been evaluated in high earthquake-prone states like Utah, California, Nevada, and Idaho. But to date, researchers have not fully examined the impact behavior of coupler/rebar connections and the component under vehicle impact using numerical and finite element analysis.

## the **RESEARCH**

There are two main objectives of this study. 1) Develop and validate two finite element models—one for small-scale specimens with single couplers, and another for half-scale columns. The small-scale model is validated against experimental results under lateral static and dynamic conditions, while the half-scale model is compared with experimental results under seismic loads. This involves calibrating material properties, mesh size sensitivity, and bond-slip laws to ensure accurate validation. 2) Using sequential and quasi-static cyclic loading protocols, assess the impact performance and residual seismic capacity of the calibrated half-scale columns following an impact event. This provides insight into the structural integrity and resilience of precast concrete columns with grouted splice sleeves (GSSs) under extreme loading conditions.

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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(s)

Andrew D. Sorensen
adsorensen@tamu.edu

## Co-investigator(s)

Mohsen Zaker Esteghamati
mohsen.zaker@usu.edu

## Research Assistant(s)

Jinghui Jiang, GRA MS


## Project Title

Numerical Modeling and Parametric Analysis of Grouted Coupler Connections under Varying Impact Loading Conditions


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## the **FINDINGS**

The results show that precast columns with GSSs at the footing-column joint have smaller average displacements than cast-in-place (CIP) columns, demonstrating better impact resistance under high-velocity impacts. GSS columns with the coupler in the column maintained structural integrity better due to added reinforcement at the base. GSS columns with the coupler in the footing perform better than cast-in-place columns but are less effective than GSS columns with the coupler in the column. CIP columns can withstand impacts from vehicles under 0.9 tons at up to 22 mph, while GSS-C and GSS columns with the coupler in the footing meet higher impact requirements.

## the **IMPACT**

The results show that low velocity vehicle impact can greatly lessen a bridge pier's capability to withstand subsequent seismic loading. As such, more investigation into a bridge pier's condition should be undertaken following an impact event. This study provides valuable insights into the behavior and finite element modeling of coupler/rebar connections under impact loading, and the residual seismic capacity of post-impact columns, enhancing the understanding and safety of ABC methods.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1194


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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