# MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 23-511 (project 609) | November 2023

## Durable Bridges Using Glass Fiber Reinforced Polymer and Hybrid Reinforced Concrete Columns

## the ISSUE

During the service life of a bridge structure, the columns are exposed to harsh environmental conditions, which have detrimental effects on structural strength. An earthquake has devastating consequences, including the collapse of bridge structures compromised because of corrosion-related concrete cracks and spalling. Post-earthquake residual displacements of bridge columns in bridges that did not collapse raise concerns about their continued safety and use.

## the RESEARCH

This research proposes a system of corrosion-resistant columns built with accelerated bridge construction using grouted ducts with ultra-high-performance grout, glass fiber reinforced polymer bars and spirals, and post-tensioning steel rods to reduce residual displacements after an earthquake. In the research, two hybrid precast concrete columns were investigated to assess their seismic performance using conventional steel and glass fiber reinforced polymer (GFRP) reinforcement. GFRP longitudinal bars and double GFRP spirals provide corrosion resistance and partial self-centering under cyclic loading. Two additional post-tensioned columns were investigated; post-tensioning was achieved using all-threaded prestressing bars to improve self-centering effectiveness using the same reinforcement as the first two specimens. All columns were connected to footings with corrugated galvanized ducts filled ultra-high-performance grout. The seismic performance of the four specimens was examined under quasi-static cyclic loads; all four specimens performed in a satisfactory manner with regard to strength and self-centering.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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## Project Title

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## the **FINDINGS**

For the columns without post-tensioning, the elastic nature of the GFRP longitudinal bars provided substantial self-centering ability by reducing the residual displacement of the hybrid column, thus enhancing its seismic resilience. Post-tensioned columns utilized high-strength all-threaded rods for post-tensioning. The combination of post-tensioning bars with GFRP longitudinal bars was effective regarding self-centering ability. The residual displacement of the post-tensioned hybrid column was decreased by 46% compared with the post-tensioned all-steel reinforced column at 6.0% drift ratio.

## the **IMPACT**

The benefit of this research is to create durable bridge columns with high resistance to corrosion and superior performance. The seismic performance was enhanced by providing post-tensioning using high-strength steel bars, which reduced the residual displacement of both all-steel and hybrid bridge columns.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1152


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.