MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 21-436 (project 545) | July 2021

Self-Centering Bridge Bent for Accelerated Bridge Construction

the ISSUE

Precast concrete construction has been proven to be very efficient in bridge engineering, especially in accelerated bridge construction (ABC) where precast concrete components are connected to save time and minimize traffic disruptions. Post-tensioned concrete structural elements, when combined with energy dissipators, create a hybrid system that ensures self-centering, energy dissipation, and minimum residual drift. This study investigates the connection of precast concrete elements with unbonded post-tensioned bars and stretch length anchors (SLAs) and their seismic performance. This was the first time this hybrid system was assembled and tested. Testing of these bridge elements and methods of connecting them is necessary to design bridges that are sustainable and resilient, allowing the transportation system to better withstand seismic events.

the RESEARCH

The research addresses a new hybrid bridge system for ABC in seismic regions. Researchers investigated the connection of precast concrete elements with unbonded post-tensioned bars and SLAs and their seismic performance. They constructed a precast concrete bridge bent consisting of two footings, two columns, and a cap beam (the entire assembly is called a "bent"). This bridge bent was tested under quasi-static cyclic load.

An experiment was carried out on a 42% scale precast, unbonded post-tensioned two-column bridge bent with external energy dissipators to evaluate its seismic and rocking behavior. The external energy dissipators were SLAs attached from the footings to the columns and the columns to the cap beam.

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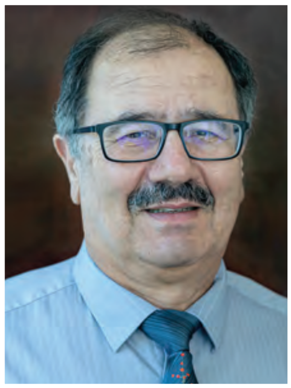

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Project Title

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the FINDINGS

The specimen displayed very good lateral strength under the given quasi-static cyclic loads and the hysteresis curves were stable and symmetric. Column rocking was controlled without large rotations or stability problems. Steel chairs holding the SLAs performed elastically and were not damaged. The SLAs yielded in tension and bending and elongated. The combination of axial load and post-tensioning forces was able to re-center the bridge bent; the residual drift ratio was 1.1%. The researchers also developed an analytical model based on the research, which is a step toward developing models that could be used to predict the behavior of actual bridge structures and analyze their seismic behavior.

the IMPACT

This is the first time unbonded post-tensioned bars were combined with SLAs in a hybrid bridge system. The replaceable feature of the SLAs makes the system seismically resilient, which means that the bridge can recover after an earthquake and be functional quickly. Given the observed residual displacement, lateral strength, hysteretic energy dissipation, and minimal damage, it is recommended that the hybrid bridge bent can be used in accelerated construction of bridges in seismic zones.

For more information on this project, download the report at https://www.ugpti.org/resources/reports/details.php?id=1041

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.