MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 19-410 (project 526) | December 2019

Seismic Rehabilitation of Reinforced Concrete Bridge Wall Piers

the ISSUE

Reinforced concrete bridge wall piers constructed using older codes perform inadequately during strong earthquakes. Deficiencies include short reinforcement lap splices, insufficient steel reinforcement ratios in the longitudinal and transverse direction, and inadequate seismic detailing.

the RESEARCH

The research presented in this report addresses seismic deficiencies found in older reinforced concrete bridge wall piers. These deficiencies include inadequate length of lap spliced bars, low reinforcement ratios for longitudinal and transverse steel reinforcement, and inadequate seismic reinforcement details. Three half-scale wall piers were constructed with older seismic code details and one wall pier with modern code seismic details. One of the piers with older seismic details was tested in the as-built condition and the other two were seismically retrofitted with carbon reinforced polymer (CFRP) rods or vertical CFRP anchors. The retrofits also included CFRP horizontal anchors and CFRP jackets for confinement. The wall pier with modern seismic code details was also tested to failure for comparison. The two retrofitted wall piers increased the initial stiffness, lateral load carrying capacity and hysteretic energy dissipation of the as-built wall pier. The damaged as-built wall pier was subsequently repaired with steel NSM bars and CFRP anchors and jackets; the damaged modern code wall pier was also repaired using a CFRP donut and headed steel bars. The repairs were successful; they increased the initial stiffness, load carrying capacity and hysteretic energy of both damaged wall piers.

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Project Title

Seismic Repair of Concrete Wall Piers Using CFRP Active Confinement

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the FINDINGS

The two retrofit methods increased the initial stiffness of the as-built pier by 110%, the lateral load carrying capacity by 73%, and the hysteretic energy dissipation capacity by 67%. The repair method of the as-built pier increased the initial stiffness of the as-built pier by 50%, load carrying capacity by 73% with similar hysteretic energy dissipation. The repair method of the code-compliant pier increased the initial stiffness by 31%, load carrying capacity by 15%, and hysteretic energy capacity by 55% for lateral displacements that reached a 6% drift ratio.

the IMPACT

The seismic retrofit of existing bridge concrete wall piers is more desirable than the replacement of such piers. Many states of the U.S. and elsewhere are in need of such seismic retrofit technologies.

For more information on this project, download the entire report at https://www.ugpti.org/resources/reports/details.php?id=982

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.