

UTC Project Information	
Project Title	MPC-526 – Seismic Repair of Concrete Wall Piers Using CFRP Active Confinement
University	University of Utah
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Funding Agencies	USDOT, Research and Innovative Technology Administration
Agency ID or Contract Number	DTRT13-G-UTC38
Project Cost	\$70,000
Start and End Dates	September 30, 2013 to September 30, 2018
Project Duration	September 30, 2013 to September 30, 2018
Brief Description of Research Project	<p>Prior to implementation of modern seismic codes, lap splicing of longitudinal reinforcement at the base of wall piers in concrete bridges was a common practice. Figure 1 shows details of lap spliced bars in wall piers; in regions of high seismicity this creates unfavorable conditions. In bridges located in high seismic regions, lap splices located in the critical hinging region of the wall pier experience bond-splitting failure of the spliced bars within the plastic hinge; this leads to stiffness and flexural strength degradation of the pier. Observations after major earthquakes show that structural damage or failure in bridges with concrete wall piers can be attributed to inferior performance of lap-spliced reinforcement at the base of the piers (Mitchell et al. 1994; Priestley et al. 1996). Figure 2 shows typical lap-splice damage from laboratory experiments that includes buckling of vertical and lateral bars (Abo-Shadi et al. 2000). Currently, AASHTO (2010, 2011) prevents splicing of pier longitudinal reinforcement at the base of the pier where plastic hinging could develop.</p> <p>The most common approach for improving the bond strength of spliced reinforcement in existing bridge piers with bond-critical regions is the use of external confinement. Methods studied include the use of steel jackets (Mitchell et al. 1994; Priestley et al. 1996; Aboutaha et al. 1999); and carbon fiber-reinforced polymer (CFRP) jackets (Priestley et al. 1996; Seible et al. 1997; Hawkins et al. 2000; Harries et al. 2006; Ghosh and Sheikh 2007; Harajli and Dagher 2008; Harajli and Khalil 2008; ElGawady et al. 2010; Bournas and Triantafillou 2011; El-Souri and Harajli 2011). A technique using a combination of CFRP jackets and CFRP anchors has also been studied (Kim et al. 2011).</p>

	<p>All of the above studies reported enhanced bond performance of the reinforcement and improved seismic response. Most of the methods used for seismic bond strengthening use passive confinement techniques - that is, techniques in which the confinement effectiveness is activated once bond-splitting cracks initiate. Because of their passive nature, most of these techniques fall short of achieving their full potential and the seismic performance of the retrofitted wall piers is inferior compared to that of wall piers designed using current codes, such as AASHTO (2011), which stipulate splice-free wall piers that are adequately confined by closely spaced transverse steel ties within the critical hinging region. Typical seismic retrofit recommendations (FHWA 2006) include steel plate encasement and bolts drilled and anchored through the thickness of the wall pier, as shown in Fig. 3; when the steel rods are tightened they provide active confinement of the lap spliced bars. A method similar to the one shown in Fig. 3 has been used with steel anchors but without the steel plate encasement with promising results (Hantouche et al. 2015).</p>
<p>Describe Implementation of Research Outcomes (or why not implemented)</p> <p>Place Any Photos Here</p>	<p>The proposed research will provide alternative methods to repair and strengthen lap splice deficiencies of concrete wall piers in existing bridges through the use of CFRP materials using active confinement.</p>
<p>Impacts/Benefits of Implementation (actual, not anticipated)</p>	<p>At least two university students will be involved in the project. One PhD student will be involved in the experimental portion of the work. A second student, will be funded from the Office of Undergraduate Research Opportunities program at the University of Utah. It is expected that a second phase of the project will be secured so that the PhD student will be able to complete his/her studies. At the local level, the technology transfer activity will involve high school students through an Annual Exploring Engineering Camp, during which small-scale models will be built to show details of the wall piers and how they would be retrofitted. In addition, the P.I. will make a presentation at the annual UDOT Engineering Conference and at other national conferences including Annual AASHTO Subcommittee on Bridges and Structures Meetings and the Annual Transportation Research Board Meeting.</p>
<p>Web Links</p> <ul style="list-style-type: none"> • Reports • Project Website 	<p>https://www.ugpti.org/resources/reports/details.php?id=982</p>