

UTC Project Information	
Project Title	MPC-427 – Fire Performance of Bridge Members Retrofitted with Near-Surface-Mounted Carbon Fiber Reinforced Polymer Composites
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Agency ID or Contract Number	DTRT12-G-UTC08, Modification No. 1
Project Cost	\$78,042
Start and End Dates	January 1, 2013 - December 31, 2013
Project Duration	1 Year
Brief Description of Research Project	<p>The need for an upgrade or repair frequently arises when the capacity of a member does not meet the current load-bearing requirement. Carbon fiber reinforced polymer (CFRP) composites are a promising material for upgrading or repairing existing structural members. CFRP materials are comprised of unidirectional carbon fibers embedded in a polymeric resin. The fibers provide load-carrying capacity of the composite and the resin binds the fibers so that stress transfer between the fibers is achieved. The advantages of CFRP composites include non-corrosive characteristics, prompt execution on site, reduced maintenance expenses, favorable strength to weight ratio, and good chemical or fatigue resistance (Teng et al. 2003, Kim et al. 2008, Kim and Heffernan 2008).</p> <p>CFRP composites may be externally bonded to the tensile soffit of a concrete member to increase load-carrying capacity. The most critical concern of such an application is the bond performance of CFRP when the retrofitted structure is subjected to mechanical or environmental loads. Previous research has reported that premature debonding failure of externally-bonded CFRP may take place because of stress concentrations at the cut-off points (Malek et al. 1998, Bizindavyi and Neale 1999, Kim et al. 2005). A combination of normal and shear stresses along the bondline influences debonding of the CFRP (Smith and Teng 2001). An alternative retrofit method called near-surface-mounted (NSM) CFRP composites has recently been developed to improve the bond behavior of CFRP (De Lorenzis and Teng 2007).</p> <p>NSM CFRP composites are an emerging technology for retrofitting existing concrete structures. A small groove is cut along the tensile soffit of a concrete member in which CFRP composites are inserted and</p>

	<p>permanently placed with a bonding agent, as shown in Fig. 1. The types of CFRP composites may be strips, laminates, and bars. Epoxy adhesives are widely used to bond the composites. The benefits of NSM CFRP applications for retrofitting concrete structures are the ease of installation, resistance to corrosion damage, reduced labor costs, improved bond characteristics when compared to externally bonded CFRP composites, and enhanced durability because the reinforcement is located inside the concrete (De Lorenzis and Teng 2007, Kotynia 2007). Given the application of NSM is still at its early stage, various technical aspects need to be examined.</p> <p>Like other structural components, CFRP-retrofitted bridge members are exposed to potential fire hazards (Garlock et al. 2012). Repaired members must, therefore, demonstrate acceptable fire resistance to ensure adequate structural integrity until travelling vehicles are evacuated. Due to the thermal deformation of a polymeric matrix that binds carbon fibers in CFRP composites, mechanical properties of the CFRP are particularly susceptible to high temperature exposure (Bisby et al. 2005a; da Silva and Adams 2007). Although insulation materials could be applied on the surface of CFRP-retrofitted structural members (Gamage et al. 2006; Williams et al. 2006), heat transfer from a fire to the retrofit system is inevitable. In fact, CFRP repair for structural members in fire is recognized as one of the primary research needs in the rehabilitation community (Karbhari et al. 2003). Little information is currently available on the thermal performance of reinforced concrete members retrofitted with NSM CFRP composites.</p> <p>The present study addresses such an identified research gap through an experimental program combined with theoretical models. The emphasis of the research is given to (1) to examining the behavior of concrete members retrofitted with NSM CFRP strips when subjected to elevated high temperatures and (2) to understanding the relationship between the performance degradation of NSM CFRP and temperature-induced distress. The emphasis of the experiment is on the residual behavior of CFRP-retrofitted concrete members, rather than the behavior during high-temperature exposure. The research program will generate much-needed test data to advance the state-of-the-art in the community.</p>
<p>Describe Implementation of Research Outcomes (or why not implemented)</p> <p>Place Any Photos Here</p>	
<p>Impacts/Benefits of Implementation (actual, not anticipated)</p>	
<p>Web Links</p> <ul style="list-style-type: none"> • Reports • Project Website 	<p>https://www.ugpti.org/resources/reports/details.php?id=840</p>