NATIONAL VIETNAM UNIVERSITY HOCHIMINH CITY
HOCHIMINH UNIVERSITY OF TECHNOLOGY

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DISSERTATION INFORMATION

Title:	FRP Strengthening of Postfire Reinforced Concrete Beams.	
Major:	Construction Engineering	Code: 9580201
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Major Contributions of This Dissertation:

This dissertation presents an experimental and theoretical investigation on the flexural performance of postfire reinforced concrete (RC) beams without/with fiber reinforced polymer (FRP) retrofitting. To achieve this aim, the research will be divided into four parts as follows.

Part one presents a study on postfire RC beams without FRP retrofitting because evaluating the performance of postfire RC beams is a crucially important step to provide information for structural engineers on the next step of retrofitting design. Experiments were performed on 15 RC beams, which were classified into 5 groups exposed to 0, 30, 45, 60, and 75 min of fire. These beams were then loaded to failure. The results showed that specimens exposed to 60 to 75 min of fire were flexural-shear failure while control specimens and beams exposed to 30,45 min of fire failed by flexure. Compared with control specimens, the yield stiffness and strength of postfire specimens were reduced by 47.5% and 13.1%, respectively, whereas yield deflection was increased by 42.6%−91.6%. The ductility of postfire specimens was decreased by up to 61.1%, resulting in moderately ductile behavior. Significant changes in yield stiffness, yield deflection, and ductility confirmed these high-priority parameters in evaluating postfire RC beams. An analytical model for estimating the moment of postfire RC beams was proposed, considering the limited information such as the fire duration obtained from actual fire events. The practicality and reasonable accuracy of the proposed model render it beneficial for structural engineers.

Part two presents a study on postfire RC beams with near-surface mounted glass fiber-reinforced polymer (NSM GFRP) retrofitting. Experiments were performed on 9 RC beams: one beam was not exposed to fire (control specimen) and eight beams were divided into two groups exposed to fire for 30 and 60 min. In each group, one beam was not retrofitted, whereas the other three beams were retrofitted using NSM GFRP. After retrofitting, all beams were loaded until failure. The experimental results confirmed that the retrofitting technique effectively recovered the strengths of postfire RC beams. The failure mode of the GFRP retrofitted beams was the peeling-off of concrete, whereas that of the control and unretrofitted postfire beams was flexural failure via the yielding of tension steel. The NSM GFRP retrofitting fully recovered or significantly increased the yield and ultimate strengths of postfire RC beams by up to 39%. The yield deflection capacity of the NSM GFRP retrofitted postfire beams was much higher than that of the control beam; however, the ultimate deflection capacity of these beams significantly decreased. Consequently, the GFRP retrofitted postfire beams were of low ductility because of the peeling-off of concrete. NSM GFRP retrofitting slightly improved but did not completely recover the yield stiffness reduced by fire. An analytical model for estimating the moment of postfire RC beams retrofitted with NSM GFRP was proposed. The results obtained from this model exhibited a reasonable accuracy.

Part three presents a study on postfire RC beams retrofitted with external bonded (EB) and NSM carbon fiber reinforced polymer (CFRP) sheet. Experiments were performed on 16 RC beams, which were divided into four groups exposed to 30, 45, 60, and 75 min of fire. After exposure to fire, these beams were strengthened by EB and NSM technique using the same amount of CFRP for comparison. These specimens were then loaded until failure. The results are compared with one another and compared with control specimens. It is found that both EB and NSM CFRP retrofitted beams failed in the form of peeling off of concrete, whereas no rupture of CFRP was observed. CFRP retrofit significantly changed the behavior of postfire RC beams, being brittle or exhibiting low ductility. The effectiveness of EB and NSM CFRP techniques was similar and it decreased with the increase in fire duration. CFRP retrofit increased the yield load-carrying capacity by 27.5%–40.9% for 30–60-min postfire RC beams and recovered the yield load-carrying capacity for 75-min postfire RC beams. CFRP retrofit significantly increased the ultimate load-carrying capacity, whereas its increasing levels depended not only on the CFRP retrofit but also on the fire duration. Both CFRP retrofitting techniques successfully recovered the yield stiffness of postfire RC beams. An analytical model for estimating the moment of postfire RC beams with EB and NSM CFRP retrofitting was proposed.

Part four presents a study on postfire RC beams retrofitted with EB CFRP sheet using U wraps. In this study, experiments were performed on CFRP retrofitted postfire RC beams, followed by theoretical analyses. Experiments were conducted on eleven RC beams, which were exposed to different fire durations and retrofitted with CFRP in flexure and shear. The experimental results

indicated that fire shifted the flexure failure to flexure-shear failure of postfire RC beams. CFRP retrofitted postfire RC beams experienced progressive peeling-off failure. FRP retrofitting significantly increased the yield deflection by 57.3−97.3% but decreased the ultimate deflection by 43.0−55.5% compared with that of the control beam. Consequently, the ductility was reduced by 69.7−74.7%, categorized as low ductility. CFRP retrofitting successfully increased the strengths of 30-min postfire beams by up to 19.7% higher than that of the control beam. Fire significantly decreased the stiffness of postfire beams by 46.4−49.2% compared with that of the control beam, whereas CFRP retrofitting did not fully recover the stiffness of postfire beams. Finally, a simple model of moment capacity of postfire beams without/with CFRP retrofits was developed based on the practicability of limited data feasibly obtained from real fires. The proposed model with its simplicity, practicability, and reasonable accuracy can be a useful tool for structural engineers in FRP retrofitting of postfire RC structures.

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