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Performance of Fiber-Reinforced Polymer as an Alternative Reinforcement

Authors : Salah E. El-Metwally, Marwan Abdo, Basem Abdel Wahed

Abstract : Fiber-reinforced polymer (FRP) bars have been proposed as an alternative to conventional steel bars; hence, the use of these non-corrosive and nonmetallic reinforcing bars has increased in various concrete projects. This concrete material is lightweight, has a long lifespan, and needs minor maintenance; however, its non-ductile nature and weak bond with the surrounding concrete create a significant challenge. The behavior of concrete elements reinforced with FRP bars has been the subject of several experimental investigations, even with their high cost. This study aims to numerically assess the viability of using FRP bars, as longitudinal reinforcement, in comparison with traditional steel bars, and also as prestressing tendons instead of the traditional prestressing steel. The nonlinear finite element analysis has been utilized to carry out the current study. Numerical models have been developed to examine the behavior of concrete beams reinforced with FRP bars or tendons against similar models reinforced with either conventional steel or prestressing steel. These numerical models were verified by experimental test results available in the literature. The obtained results revealed that concrete beams reinforced with FRP bars, as passive reinforcement, exhibited less ductility and less stiffness than similar beams reinforced with steel bars. On the other hand, when FRP tendons are employed in prestressing concrete beams, the results show that the performance of these beams is similar to those beams prestressed by conventional active reinforcement but with a difference caused by the two tendon materials' moduli of elasticity.

Keywords : reinforced concrete, prestressed concrete, nonlinear finite element analysis, fiber-reinforced polymer, ductility
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