Structural Performance of Hybrid Reinforced Concrete Beams Containing Polyvinyl Alcohol Fibers Under Thermal Loads

By

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Abstract

This study focused on the efficiency of concrete beams containing polyvinyl alcohol fibers (PVA) under thermal loads. The eighteen concrete beams were reinforced with hybrid bars or a combination of GFRP bars and steel reinforcement bars (hybrid scheme). The main experimental variables were the level of temperature (25°, 300°, and 600° C), PVA fiber volume (0%, 0.50%, and 1.0%), and the flexural reinforcement bars. The experimental test results are discussed in terms of the first crack load, flexural capacity, and load-deflection curves. Moreover, the initial and post-crack stiffness, ductility factor, and failure modes are discussed. The test results demonstrated a significant increase in the capacity of PVA concrete beams reinforced with hybrid reinforcement bars. At a temperature of 300° C, the inclusion of 0.50% and 1.0% PVA ratios improved the flexural capacities by 11% and 24%, respectively. Furthermore, the addition of PVA fibers enhanced the toughness by 34% and 67%, respectively, when compared to normal concrete beams. The results also demonstrate that using PVA fibers prevents the spalling of concrete beams after exposure to elevated temperatures. At a temperature of 600° C, an increase in fiber content leads to a proportional increase in the number of pores and channels created during fiber melting and a corresponding decrease in strength. Finally, a nonlinear finite element analysis (NLFEA) simulation was performed to verify the experimental test results and supplement experiments by predicting the results that are difficult to accomplish through experiments. With an average ratio of 1.02 between experimental and NLFEA ultimate capacity, the numerical results were an exact match of the patterns observed in the experimental results.

Keywords: Hybrid reinforcement bars, PVA; RC beams; ANSYS, thermal loads.