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Performance of Reinforced Concrete Beams under Different Fire Durations

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Abstract : Performance evaluation of reinforced concrete (RC) beams subjected to accidental fire is significant for post-fire capacity measurement. Mechanical properties of any RC beam degrade due to heating since the strength and modulus of concrete and reinforcement suffer considerable reduction under elevated temperatures. Moreover, fire-induced thermal dilation and shrinkage cause internal stresses within the concrete and eventually result in cracking, spalling, and loss of stiffness, which ultimately leads to lower service life. However, conducting full-scale comprehensive experimental investigation for RC beams exposed to fire is difficult and cost-intensive, where the finite element (FE) based numerical study can provide an economical alternative for evaluating the post-fire capacity of RC beams. In this study, an attempt has been made to study the fire behavior of RC beams using FE software package ABAQUS under different durations of fire. The damaged plasticity model of concrete in ABAQUS was used to simulate behavior RC beams. The effect of temperature on strength and modulus of concrete and steel was simulated following relevant Eurocodes. Initially, the result of FE models was validated using several experimental results from available scholarly articles. It was found that the response of the developed FE models matched quite well with the experimental outcome for beams without heat. The FE analysis of beams subjected to fire showed some deviation from the experimental results, particularly in terms of stiffness degradation. However, the ultimate strength and deflection of FE models were similar to that of experimental values. The developed FE models, thus, exhibited the good potential to predict the fire behavior of RC beams. Once validated, FE models were then used to analyze several RC beams having different strengths (ranged between 20 MPa and 50 MPa) exposed to the standard fire curve (ASTM E119) for different durations. The post-fire performance of RC beams was investigated in terms of load-deflection behavior, flexural strength, and deflection characteristics.

Keywords : fire durations, flexural strength, post fire capacity, reinforced concrete beam, standard fire
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