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Numerical Investigation of Post-Fire Structural Behavior of Reinforced Concrete Beams

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ABSTRACT

Fire-damaged reinforced concrete (RC) members, when cooled to ambient temperature, undergo not only mechanical property degradation due to elevated temperatures but also additional thermal damage during cooling phase, resulting in increasingly complex structural behavior. In particular, RC beams exhibit combined flexural and shear behaviors, making it essential to quantitatively assess their nonlinear structural response under post-fire cooling conditions. The current study numerically investigates how the fire exposure affects the structural behavior of RC beams, especially after they are cooled to ambient temperature. To realistically simulate the response of the fire-damaged RC beams, a series of thermo-mechanical coupled finite element analysis was implemented by linking heat transfer analysis with structural analysis. The validity of the proposed modeling approach was verified through the comparison with existing experimental results provided by Ahmad and Bhargava (2023). After the validation, the post-fire behavior of RC beams was numerically assessed with key parameters of fire exposure time, shear span-to-depth ratio, and stirrup spacing, and structural sensitivity and failure mode transitions of the fire-damaged beams were systematically analyzed. It was revealed that the degradation of material properties and changes in structural behavior were highly sensitive to fire exposure duration, flexure-shear interaction, and the amount of shear reinforcement, greatly affecting the residual structural capacity and failure modes.

REFERENCES

Ahmad, M. S., and Bhargava, P. (2023). “Effect of different load levels on the flexure performance of RC beams exposed to fire”, Materials Today: Proceedings.

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