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Numerical and experimental investigation on the effect of heat release rate in the evolution of fire whirls

A. Cantizano González; P. Ayala Santamaría; E.M. Arenas Pinilla; J.R. Pérez Domínguez; C. Gutiérrez Montes

Abstract-

Buildings with large internal spaces, such as vertical shafts or atria, are widespread nowadays. In the case of fire, internal air currents may generate devastating fire whirls that can cause severe damage due to intensive heat release rate (HRR) and temperatures. This work presents the generation and evolution of fire whirls in a full-scale atrium experiment and their comparison with a numerical approach. A set of numerical models using FDS 6.7.5 are tested to assess the influence of the HRR curve and the impact of intrusive methods of temperature measurements on the prediction of whirls. The results show that the Burgers vortex model is well reproduced, although the continuous flame and plume regions can only be distinguished with fine grids. However, the periodic evolution of the whirls is better predicted with a time-averaged HRR curve, showing its influence on the flame height. The use of the experimental HRR curve presents more accurate results only in the temperatures far from the flame, with errors lower than 8.5% even for coarse grids. In addition, a small obstacle above the flame is observed to affect the formation of the whirls, which consequently impacts the grid sensitivity and computational cost.

Index Terms- Fire whirl; Heat release rate; Atrium; Full-scale experiments; FDS; Intrusive measurements

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