

Factors affecting the make-up air and their influence on the dynamics of atrium fires

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Abstract— In case of fire, constructive features of typical atria could favor the spread of smoke. This makes the design of their smoke control and management systems a challenging task. Five full-scale fire experiments in the literature have been analyzed and numerically compared in FDS v6 to explore the influence of the make-up air. However, these fire experiments cover only a limited number of set-ups and conditions, and require further numerical modeling to obtain a deeper understanding of the makeup air influence. Subsequently, 84 simulations with FDS v6 have been carried out, considering different vent areas (air velocity from 0.4 to 5.3 m/s) and configurations, two heat release rates (2.5 and 5 MW), and two pan locations. It is demonstrated that make-up air velocities lower than the prescribed limit of 1 m/s, by the international codes, may induce adverse conditions. Based on our results, we recommended fire engineers to numerically assess the fire scenario with even lower velocity values. The results also show that asymmetric configurations are prone to induce circulation around the flame which can contribute to the formation of longer flames and fire whirls. Thus, this numerical study links two fire types allowing the connection of pool fires to fire whirls, which completely differ in behaviour and smoke filling, for the sake of design of fire safety.

Index Terms— Full-scale fire experiment, Fire dynamics simulator (FDS), Make-up air, Smoke management, Fire whirls

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