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THE ROLE OF ATRIA IN THE PASSIVE VENTILATION OF MULTI-STOREY BUILDINGS – A STEADY FLOW ANALYSIS

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A theoretical study of the fluid mechanics of steady passive ventilation flows in multi-storey atrium buildings is presented. The emphasis is on the prediction of the bulk steady airflow properties, specifically the thermal stratification and ventilation flow rates, as driven by heat gains within the building. The motivation for this work derives from an almost complete absence of knowledge on these flows and of the parameters that govern them. Consequently, there was very limited design guidance at the outset.

A simplified theoretical model is developed to describe the airflows in a generic two-storey atrium building – the geometry considered consists of two identical rooms, ventilated via high- and low- level openings, stacked vertically and connected via their high-level openings to a common atrium. The model reveals the governing geometric and airflow parameters, and the dependence of the flow on them. Counterintuitive effects were identified. For example, for the upper storey of a two-storey atrium building the effect of increasing the ventilation area beyond a critical (and determined) value results in a decrease in the airflow rate. Additionally, we show an atrium does not guarantee that airflow rates through the adjoining rooms will be enhanced and guidance is provided to determine those atrium designs which genuinely enhance the flow.

The theoretical model was then generalised to multiple storeys. Predictions reveal that the basic pattern of flow was qualitatively similar to that predicted for two storeys. Typical high-rise atrium building designs were shown to severely restrict the airflow through the upper storeys - to overcome this potential design failure a new design methodology was determined. This first detailed study of multi-storey atrium building ventilation provides an insight into both buoyancy-driven flow in connected spaces and the outcomes from it are presented in a way which may be readily used to inform design