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Abstract

Ventilative cooling can be an energy-efficient measure to reduce indoor overheating while maintaining the thermal comfort of the occupants. An accurate assessment of the effect of ventilative cooling on the indoor air and surface temperatures and convective heat fluxes can be performed using numerical modeling with Computational Fluid Dynamics (CFD) provided that these simulations are validated with high-quality wind-tunnel experiments. This paper presents wind tunnel measurements and an analysis of cross-ventilation in an isolated building with a heated sidewall. The measurements were performed in an atmospheric boundary layer (ABL) open circuit wind tunnel with a closed test section with dimensions 0.9 × 0.6 × 4.5 m^3 at the University of Southampton in the UK. A generic cubic building with dimensions 150 × 150 × 150 mm^3 was considered. The forward and rear-facing walls had openings with dimensions 70 × 40 mm^2 (L × H) ensuring cross-ventilation of the building and one of the sidewalls of the building was heated to 60°C to create a source of buoyancy. The measurements were performed for a Reynolds number (Re) of 15,600. The indoor velocities and turbulence levels in the vertical center plane were acquired using Particle Image Velocimetry (PIV), and temperatures were also obtained in both the vertical center plane and a vertical plane 50 mm from the heated wall using NTC sensors. In addition to the PIV measurements, surface heat fluxes were measured at six locations on the heated wall. The measurement data can be used for the validation of CFD simulations and results from other numerical models of non-isothermal cross-ventilation flows, which is at the moment very difficult due to a lack of published experimental data.

Keywords: Wind tunnel experiments, PIV, natural cross-ventilation flow, convective heat transfer, ventilative cooling.

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