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THREE-DIMENSIONAL STUDY OF NATURAL CONVECTION IN COMBINED DOUBLE-SKIN FAÇADE/ROOF CONFIGURATION

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As the performance of Building-integrated photovoltaic (BIPV) systems is highly sensitive to the design of the building skin this paper is aimed at advancing the understanding of a combined double-skin façade/roof configuration relevant to real buildings. A combined double-skin configuration which includes both vertical and inclined sections of the open ended channel was studied to achieve a sufficient understanding of the flow and heat transfer phenomena. The flow and thermal fields were modelled using a well-validated three-dimensional in-house Large Eddy Simulation (LES) code as well as ANSYS Fluent software. A modified Vreman SubGrid-Scale (SGS) model has been adopted as it has been shown to be superior to other SGS models for natural convection in the open ended channels in capturing both the instantaneous and time-averaged components of the temperature and velocity fields. The development of the flow and its possible transition from the laminar to the turbulent regime in this double-skin configuration was investigated.

It is shown that separation of the flow in the corner between vertical and inclined walls of the channel causes temperature and flow instabilities, resulting in complex flow structures propagating along the inclined channel. These unsteady flow structures lead to enhanced mixing in the inclined part of the configuration and to transition of the flow to turbulence. The mass flow rate of the entrained air was shown to be higher for the façade-roof configuration ($3.75 \cdot 10^{-2}$ kg/s) compared with the façade only configuration ($2.4 \cdot 10^{-2}$ kg/s) which is beneficial for the passive cooling of such systems.