The Closed Cavity Façade (CCF): Optimization of CCF for Enhancing Energy Efficiency and Indoor Environmental Quality in Office Buildings

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Abstract : Buildings, in which we spend 87-90% of our time, act as a shelter protecting us from environmental conditions and weather phenomena. The building's overall performance is significantly dependent on the envelope’s glazing part, which is particularly critical as it is the most vulnerable part to heat gain and heat loss. However, conventional glazing technologies have relatively low-performance thermo-optical characteristics. In this regard, during winter, the heat losses due to the glazing part of a building envelope are significantly increased as well as the heat gains during the summer period. In this study, the contribution of an innovative glazing technology, namely Closed Cavity Façade (CCF) in improving energy efficiency and IEQ in office buildings is examined, aiming to optimize various design configurations of CCF. Using Energy Plus and IDA ICE packages, the performance of several CCF configurations and geometries for various climate types were investigated, aiming to identify the optimum solution. The model used for the simulations and optimization process was MATELab, a recently constructed outdoor test facility at the University of Cambridge (UK). The model was previously experimentally calibrated. The study revealed that the use of CCF technology instead of conventional double or triple glazing leads to important benefits. Particularly, the replacement of the traditional glazing units, used as the baseline, with the optimal configuration of CCF led to a decrease in energy consumption in the range of 18-37% (depending on the location). This mainly occurs due to integrating shading devices in the cavity and applying proper glass coatings and control strategies, which lead to improvement of thermal transmittance and g-value of the glazing. Since the solar gain through the façade is the main contributor to energy consumption during cooling periods, it was observed that a higher energy improvement is achieved in cooling-dominated locations. Furthermore, it was shown that a suitable selection of the constituents of a closed cavity façade, such as the colour and type of shading devices and the type of coatings, leads to an additional improvement of its thermal performance, avoiding overheating phenomena and consequently ensuring temperatures in the glass cavity below the critical value, and reducing the radiant discomfort providing extra benefits in terms of Indoor Environmental Quality (IEQ).

Keywords : building energy efficiency, closed cavity façade, optimization, occupants comfort
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