

Design and thermal performance analysis of a dynamic shading device incorporating phase change materials

Margarida Gonçalves¹, António Figueiredo¹,

Ricardo M.S.F. Almeida^{2,3}, Romeu Vicente¹

Recognizing the substantial carbon footprint of the building sector, there is a growing emphasis on decarbonization strategies that aim to improve the energy and thermal performance of the built environment, thereby reducing overall energy consumption and greenhouse gas emissions. Dynamic façades can play a crucial role in achieving this objective, as their adaptability to environmental changes can boost both energy efficiency and thermal comfort in buildings. Moreover, the increasing trend of integrating Phase Change Materials (PCM) into building envelopes highlights their considerable potential for improving thermal performance. In this framework, a novel dynamic shading device incorporating PCM (DS-PCM) was developed to mitigate overheating. The system operates by sliding the device from an indoor compartment (highlighted in red in the Figure)

to a discharging chamber connected to the outdoor environment (highlighted in blue) to potentiate the PCM phase change and heat dissipation. A full-scale prototype was tested in two identical compartments: one equipped with a conventional curtain (REF), and the other with the DS-PCM device. An experimental campaign was conducted to assess the system's performance according to different operational strategies. The results showed that the DS-PCM device reduced indoor maximum peak temperatures by up to 2.1°C, lowering the Degree-Hours Discomfort index by up to 20%, and decreasing overheating periods by up to 7%, thus improving indoor thermal comfort. Future research will focus on optimizing the system's operation to further enhance the compartment's thermal performance, by dynamically controlling the device's movement in response to the PCM's real-time temperature.

1 – RISCO & Civil Engineering Department, University of Aveiro.

2 – Department of Civil Engineering, Polytechnic Institute of Viseu.

3 – CONSTRUCT-LFC, University of Porto.

FIGURE 1

Schematic view of the operating principle of the DS-PCM device.

