Thermal, daylighting and energy performance of glazing systems with solar control films

Summary

Façades of recent buildings, especially the commercial ones, have been built with a high window-to-wall ratio window-to-wall ratio, such as curtain walls, double-skin façades and skylights. Despite the appealing design from the aesthetic standpoint and allowing pleasant daylighting levels, this architectural trend can nevertheless give rise to thermal and luminous indoor discomfort problems. Solar gains through glazing systems, especially in climates with long and hot summers, contribute significantly to cooling loads and lead to overheating of indoor spaces and/or glare problems, disrupting users' productivity.

This work's main objective was to evaluate the thermal, luminous and energy performance of glazing façades with solar control films (SCFs) through an experimental study conducted in situ and a building energy simulation approach using experimentally calibrated models. For this purpose, several office rooms were selected from two different buildings, which constitute the present doctoral thesis's case studies. The first building has clear single glazing on the windows' façade and the second one has double-glazing systems with a solar control coating incorporated. In both buildings, adjacent office rooms were selected to be monitored, where SCFs were installed on the glazing except in one office left with the original window without SCFs, which serves as a basis for comparison (reference office). The selection of several office rooms with identical geometry, constitution, solar orientation, and occupancy characteristics, with and without SCFs installed on the glazing, allows to assess the existing thermal and visual comfort conditions without SCFs and to perform a comparative analysis of the effects of the SCFs application on the indoor conditions.

The experimental field data was also used to calibrate the geometrical models of the office rooms of both of the buildings in a well-established building energy simulation program (EnergyPlus) to perform a more comprehensive and thorough study on the impact of the window films' application in existing windows of office spaces.

An environmental and economic study was also performed for the three SCFs that showed the highest thermal, visual and/or energy performance. This study considered the application of the films as a retrofitting scenario of the existing glazing systems of the second building used as case study. The complete replacement of the existing windows with a new one was also analysed as an alternative scenario.

Finally, a parametric analysis was performed to evaluate the thermal, visual and energy performance and the global performance of a typical second case study building office for different solar orientations, types of glazing, climate, and glazing area on the façade.

Keywords

Window retrofitting, solar control films, visual performance, thermal performance, energy efficiency, office buildings, in-situ measurements, energy simulation.

External view of the building of the case study – main entrance.

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Period
2016-2022

Funding
FCT scholarship (PD/BD/127848/2016)