The effects of transparent adaptive façades on energy and comfort performances in office buildings

Electrochromic glazing, dynamic shading devices and double-skin façades

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ABSTRACT

This study focuses on the effects of adaptive façades on the energy, thermal (and visual) comfort performances. In fact, by studying their impacts, their efficiencies are determined and help in the decision-making of adaptive façades. Four technologies from four different adaptive façades families are simulated through the software EnergyPlus. The effect of different control strategies and parameters are also studied.

KEYWORDS

Energy performance, thermal comfort, visual comfort, adaptive façades, dynamic envelopes, electrochromic glazing, dynamic shading, double-skin façade, modeling, simulation

PROBLEM

Due to the current context of the climate change, the energy-efficiency of the construction sector become important. Furthermore, there is a need to take care of the indoor comfort of occupants in buildings. In addition, due to the present needs and all new and future innovations, the European Union intends to recognize the smartness of building with a *Smart Readiness Indicator* (SRI). Building envelopes are the interface between the outdoor and the indoor environment and could have important impacts on the energy and comfort performances of buildings. Moreover, innovative building envelopes that are adaptive façades, could become one of the key solutions to reduce environmental impacts and increase the performances of buildings.

OBJECTIVES

The main objective of this study is to help in the decision making of adaptive façades by studying the influence of adaptive façades on the energy and comfort performances.

AUDIENCE

Construction sector, students, researchers, engineers, architects,…

RESEARCH QUESTIONS

- What is the influence of the different dynamic technologies on energy consumption and comfort in smart office buildings?
- How to optimize, with strategic controls, thermal comfort and energy efficiency in smart office buildings with the technologies studied?
- What are the factors that determine the smart readiness of a dynamic envelope?

INNOVATIVE

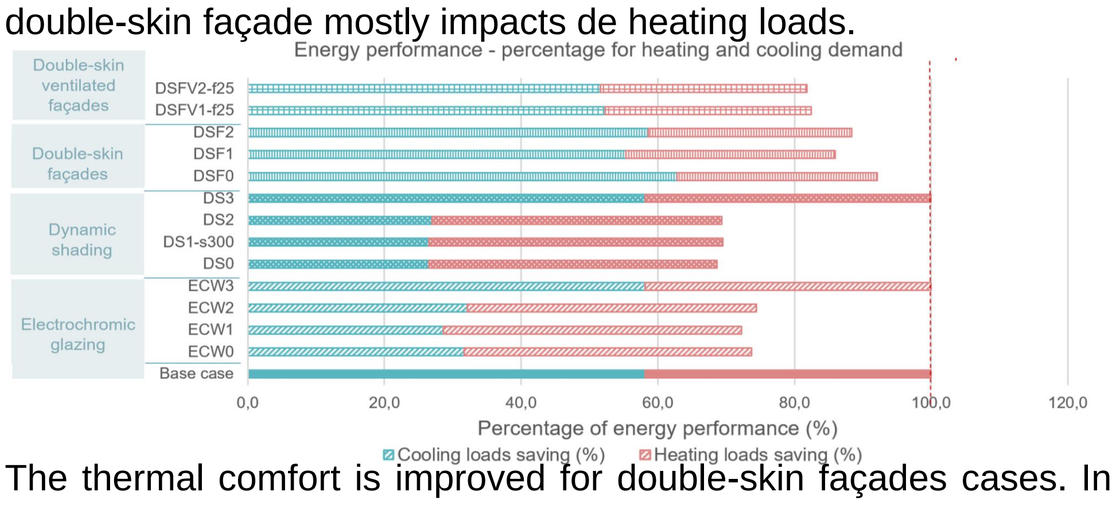
- Different technologies from different adaptive façade families are studied. Usually, previous studies investigated technologies from a single one family (only chromogenic glazing or double-skin façade for example).
- The effect of control strategies is analyzed.
- Three impact criteria are studied: Energy consumption, thermal and visual comfort.
- Sensitivity analyses are made to determine influential parameters.

METHODOLOGY

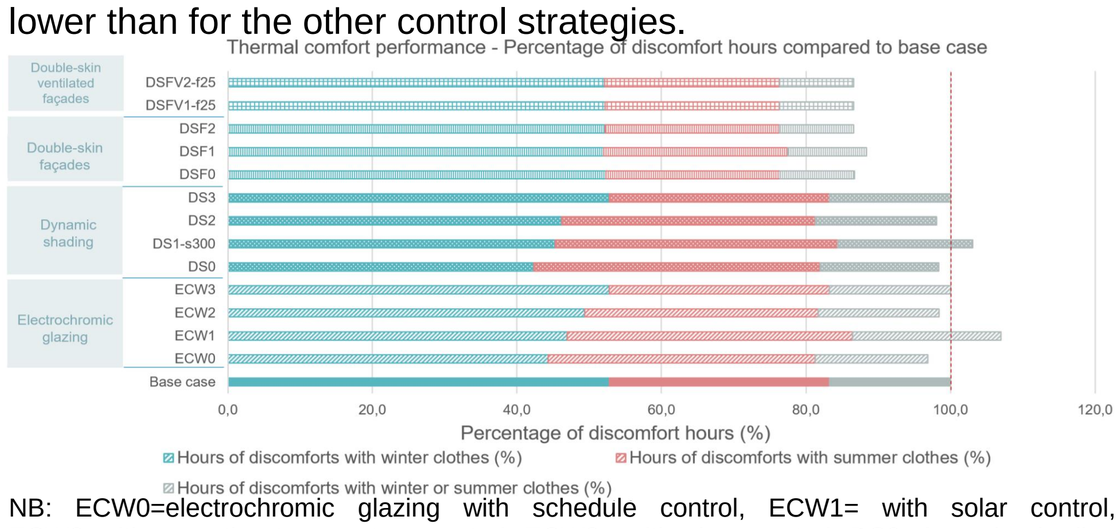
The base case is based on the BESTEST case 600. This one is modeled and simulated with the help of DesignBuilder tool (EnergyPlus). Then each technology are implemented and compared to each others and to the base case. The location is set to Uccle, in Belgium. To strengthen the results, sensitivity analyses are performed.

RESULTS

Results shows that dynamic shading with schedule control (DS0) has the best energy performance. In general, electrochromic glazing and dynamic shading mostly impact the cooling loads while double-skin façade mostly impacts de heating loads.



The thermal comfort is improved for double-skin façades cases. In fact electrochromic glazing and dynamic shading cases do not really influence the thermal comfort. Due to the current context of climate change and regarding figure below, operative temperature control (ECW2, DS2) seems to have better thermal comfort performance since the discomfort hours with summer clothes are lower than for the other control strategies.



NB: ECW0=electrochromic glazing with schedule control, ECW1= with solar control, ECW2=with operative temperature control, ECW3= with glare control, DS0=dynamic shading with schedule control, DS1=with solar control, DS2=with op. temp. control, DS3=with glare control, DSF0=double-skin façade with no vent., DSF1=with natural ventilation and schedule control, DSF2=with natural vent and op. temp. control, DSFV1= double-skin façade with mechanical ventilation and op. temp. control, DSFV2= with hybrid ventilation and op. temp. control.

CONCLUSION

By studying several adaptive façade families, an overview of their potential is possible. Furthermore, by analyzing three domains and different control strategies, this study helps in the decision making of these types of façades. To help future research on the topic, the base case chosen is internationally known and can be easily simulated through different building performance simulation tools.

RESSOURCES

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