Expert decision support for early design stage of facades for office buildings in Belgium: A parametric approach

Auteur : Nassimos, Meray
Promoteur(s) : Attia, Shady
Faculté : Faculté des Sciences appliquées
Diplôme : Master en ingénieur civil architecte, à finalité spécialisée en ingénierie architecturale et urbaine
Année académique : 2020-2021
URI/URL : http://hdl.handle.net/2268.2/13017

Expert decision support for early design stage of facades for office buildings in Belgium: A parametric approach

Design tools, energy approach, Daylighting, Window-to-wall ratio, Grasshopper, simulation

Auteur : Nassimos, Meray
Promoteur : Attia, Shady
Faculté : Faculté des Sciences appliquées
Diplôme : Master en ingénieur civil architecte, à finalité spécialisée en ingénierie architecturale et urbaine
Année académique : 2020-2021

Summary

The facade is one of the most important elements of a building that requires careful planning. In addition to being central in defining a building's identity and image, the facades also contribute to energy consumption and user comfort positively or negatively, especially in an office building, where facades are the main factors that influence energy efficiency.

However, the most important design parameter that integrates into the design process, particularly for window design, is the window-to-wall ratio (WWR). This indicator, with window characteristics, has an impact on the amount of daylight passing inside a room, on the energy use intensity and occupants comfort.

Thus, the main aim of the research presented in this paper is to support the design decision for facades. The methodology was to create a parametric design process for designing façades in Belgium, particularly for office buildings, based on the building's thermal environment performance. First, a simulation through EnergyPlus, Open studio, and Radiance was used with the help of Grasshopper in Rhino. Speed is essential. For that reason, a user-friendly interface tool was developed for this purpose. Thus, it will help designers to choose the desired design based upon a need quickly. Furthermore, designers can use this to do comparative studies to support decision-making for different proposed solutions, especially at the early design stage.

In addition, the study aims to take into account the correlation between facades parameters, such as the Window-to-Wall Ratio (WWR), U_{window} value, Solar Heat Gain Coefficient (SHGC), window division, window sill height and building orientation; and thus, study their degree of sensitivity and their impact on visual comfort, thermal comfort and energy efficiency. In addition, a focus on the most influential parameters that we should be aware of during the decision-making is discussed.

Results from different scenarios have been compared, and a sensitivity analysis followed to find the most influential facade parameters. It is demonstrated that WWR has a remarkable influence on daylight metrics and the Solar Heat Gain Coefficient on

energy demand and thermal comfort, with a most negligible impact caused by window sill height and window division. Finally, a focus on the best design cases is mentioned.

In conclusion, this study helps to determine the degree of impact of facade parameters which will lead architects to better understand the influence of each parameter on the results and modify the variables according to their needs using a user-friendly interface.