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FACADES MODULES FOR ECO-EFFICIENT REFURBISHMENT OF BUILDINGS

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Facade, energy efficiency, thermal comfort, refurbishment.

ABSTRACT

The search for new technologies for energy efficiency in buildings is urgent once conventional technologies currently used in the refurbishment of buildings in most of the cases are not efficient. Facades are a privileged component to propose solutions, because contribute significantly to the heat transfer between indoor and outdoor environment. Therefore, the objective of this research is to develop a new facade system named "Facade Modules for Eco-Efficient Refurbishment of Buildings". The methodology consists on the use of computational simulation for thermal comfort and daylight conditions determination. Furthermore, some of the system components were characterized by experimental tests: glass spectrophotometer test and wind tunnel test for ventilation modules. As a result, expressive decrease of the energy consumption has been observed with the use of this modular facade.

INTRODUCTION

The main function of the facade is to create adequate living conditions for the building, protecting the indoor environment against the undesirable actions of several agents (heat, cold, sun, rain, wind, humidity, noise, etc.) and controlling them. Facade defines the potential of the building more than any other element and it should be flexible as such. This flexibility could be reached in several ways, for example, in terms of techniques, implementation of solutions with mobile, replaceable and exchanged elements. Various facade system producers and architects have recently developed service integrated facades. These are composed by parts with fixed glazing, operable windows and decentralized HVAC service installations (Castrillón 2009; Compagno 2009; Ebbert & Knaack 2008; Ochoa & Capeluto 2008). However, there are a large number of elements and configurations that can be chosen, and must be considered as parameters: cost, aesthetics, solar orientation, openings, glass and others (Ochoa & Capeluto, 2008). On this topic, the goal would be the development of a dynamic and flexible facade system in order to adapt to the climatic changes, to the occupants requirements and, however, to adapt to the building. An improvement would be the development of a system that facilitated the assembly of the facade, containing passive elements, glazing and solar energy captation to improve the comfort conditions in agreement with the climatic needs and be mounted according to solar orientations and required functions (Sacht 2010).

The main objective of this research is the development of a new modular facade system composed by small adjustable elements (standard module, Trombe wall module, sunspace module, ventilation module, photovoltaic module and sun protection modules) aiming at high energy efficiency, flexible and versatile application. The specific objectives to achieve in this research are: 1) Modules conceptual definition; 2) Studies on integration and optimization of building elements; 3) Physics characteristics optimization; and 4) Constructive details accomplishment.

METODHOLOGY

The methodology consists in using computational simulation for the determination of thermal comfort, daylight and, furthermore, the characterization of some system components. Furthermore, glass spectrophotometer test and wind tunnel tests for the ventilation module were carried out.

RESULTS

An example of computational simulation (thermal performance) and spectrophotometer test results are presented to illustrate part of the research development.

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Thermal Performance Simulations

Figure 1 presents, as example, thermal performance results only for Porto climate (Portuguese conventional system). However was analyzed nine climates of Portugal. For all analized climates, glazing 04 (Cool Lite KNT 155 4mm Green - Planitherm Futur Ultra N 4mm) had a better performance to reduce cooling needs and glazing 07 (BIOCLEAN 4mm - 4mm PLANILUX) to decrease heating needs.

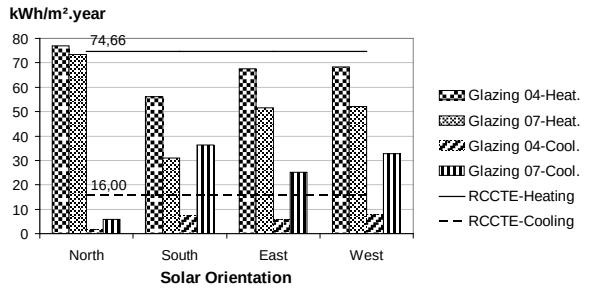

Figure 1: Porto: Heating an cooling needs for the Portuguese conventional system

Although not presented in this paper, Trombe wall passive solutions reducing energy consumption for heating and ventilation modules contributed to decrease energy consumption for cooling.

Glass Spectrophotometer Test

Figure 2 presents as example, glazing transmittance values.

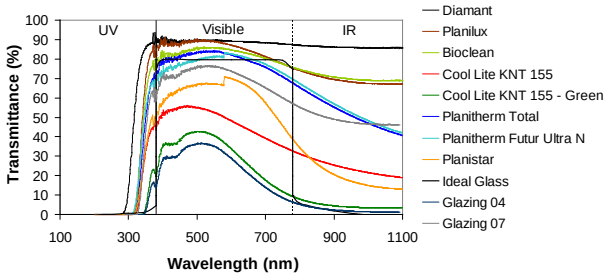

Figure 2: Glass Transmittance Results

Glass Cool Lite KNT 155 Green indicated a better daylight performance (visible region) and attenuates the infrared radiation, reducing the heat gain, which occurs precisely in this spectrum region. This results are in accordance with thermal performance simulations.

FINAL REMARKS

Facade systems should be suitable to be used in refurbishment and new buildings to take advantage of solar radiation for heating. It is being observed significant energy consumption decrease with the use of this modular facade system, mainly due to the use of passive solar modules.

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